May 1982

The independent magazine for the independent user

sinclair user

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We gaze upon the ZX Spectrum

Eight pages of glorious programs

A layman's guide to machine code

COS, SIN, TAN explained

Discover how the ZX-81 is manufactured

Plus: helpline, mind games, new products, book reviews

BUG-BYTE



ZX81 SOFTWARE

BUG-BYTE ADVENTURES

The Damsel and the Beast
A game of concentration and suspence in which you, the intrepid hero, must wander in the darkness and dangers of the Beast's palace, find the Damsel hiding or imprisoned there, kill the Beast, and then last but not least, lead the Damsel to the palace exit before she starves to death. An extremely complex, frustrating and entertaining game.
Price £6.50

Dictator
You have just become the 129th president for life of the state of Ritimba. The object of your rule is to do what all previous presidents failed to do, that is, to take full advantage of the situation for your own good.
The program is supplied on high quality cassette, together with an 8 page booklet containing detailed descriptions, instructions and hints.
Price £9.00

Star Trek
The classic computer game in which you trek across the galaxy in search of Klingons to zap with your phasers and photon torpedoes. You have long and short range scanners to help you find them, Starbases to refuel your ship at and, of course, various witty comments from the crew.
Price £6.50

House of Gnomes
Another fantastic adventure game for the 16K ZX81.
Price £7.00

INVADERS

Fast moving, machine code version of the famous arcade game, for the 16K ZX81. Shields are provided to help protect you from the bombs of the marching aliens. Ten levels of play from easy to suicidal. On screen scoring.
Price only £4.00

BUG-BYTE UTILITIES

ZXAS £5.00

This full specification Z80 Assembler assembles all the standard Zilog mnemonics, which are simply written into REM statements within your BASIC program. When assembled, the assembly listings, together with assembled codes and addresses are displayed on the screen. The assembled codes and addresses, are displayed on the screen. The assembled code is executed by USR. The program occupies 5K. This means that ZXAS maybe used in conjunction with ZXDB. The program is available for both the 16K ZX81 and the 8K ROM ZX80. Full documentation on how to use the assembler (including a list of the mnemonics) is supplied.

ZXDB £6.50

The perfect complement to the ZXAS assembler, ZXDB is a complete combined machine code disassembler and debugging program.
Apart from the DISASSEMBLER, the program has features inc including SINGLE STEP, BLOCK SEARCH, TRANSFER AND FILL, HEX LOADER, REGISTER DISPLAY and more, all of which are executed by simple one key commands from the keyboard.

ZXTK £6.00

ZXTK enhances the facilities offered by ZX81 BASIC - a must for the serious BASIC programmer. Includes full re-numbering, the ability to manipulate groups of lines and merge files, read filenames from tapes and more.

RENUM £4.00

Renum is a full renumbering program. Renumbers line numbers, GOTOs and GOSUBs, and will renumber existing programs.

BUG-BYTE GAMES PACKS

Program Pack	1	£3.50
Program Pack	2	£3.50
Program Pack	3	£4.50
Program Pack	4	£4.50
Program Pack	5	£4.50
Program Pack	6	£4.50
Program Pack	7	£5.00
Program Pack	8	£6.00

OTHERS

Multifile
A multipurpose filing system for the 16K ZX81. A wide range of possible applications.
Price £17.50

Videograph
Graphical display and testing program. Hundreds of possible applications.
Price £7.50

Viewtext
Paged information system for the 16K ZX81. Great for displays
Price £7.00

Constellation
Turn your ZX81 into a telescope. Gives an accurate representation of the night sky on any date of the Century.
Price £8.00

All prices inclusive.

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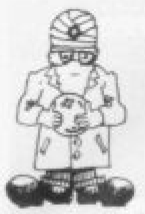
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NEXT MONTH

- **The ZX-Spectrum analysed in depth**
- **Who is THE WINNER OF OUR FIRST COMPETITION?**
- **An indepth look at graphics software**



ZX-82 will be around soon

No other personal computer has had the sales that the ZX-81 has had—and none has come close. The sales of the pocket-book sized computer are rapidly approaching 400,000. Looking back to last month's *Sinclairvoyance*, we speculated about the arrival of the ZX-82 computer. A machine with a better specification than the BBC Micro, and built by Clive Sinclair, is enough to whet any Sinclair user's appetite.

The ZX-82 is coming very soon! Many potential ZX-81 owners are put off this marvellous little computer by the fact that it does not have a full-size keyboard or colour graphics or sound output. The **Spectrum,** as the ZX-82 is likely to be called, will have all these features plus more. With its own matching ZX Microfloppy, and retailing for approximately £140, this unit will be available through mail-order only, until a suitable distributor can be found. The new computer is likely to have 32K RAM fitted as standard.

The ZX-81 succeeded the ZX-80 in February 1981 when the ZX-80 users found that the machine was not quite powerful enough. The ZX-80 owners upgraded to the ZX-81 specification by inserting a new 8K ROM with floating-point arithmetic, to replace the old integer-only 4K ROM. Unfortunately, ZX-81 owners will not be so lucky—it will not be possible to interface the ZX Microfloppy to the ZX-81, and there are going to be no new ROMs for the ZX-80 or '81. This is because of the technical difficulties of trying to get the other features of the ZX-82 on the ZX-81.

The Prestel adaptor which was due to be launched at the Computer Fair will have to be one of two possible types. It will either use the ZX-81's own 32 × 24 black and white screen for its output, or it will have a standard 40 × 25 teletext format. If it has the former, it will only be able to pick up *Telsoftware*, whereas if it has the latter, it would also be able to pick up Prestel pages of information.

What I am leading up to, is that if the ZX-82's ROM could be copied and used in conjunction with suitable colour Prestel adaptor, it *might* be possible to implement some of the ZX-82's capability on the ZX-81.

When the BBC computer was announced, Clive Sinclair said that he could meet the specification laid down for about half the price. It now appears as though he has done it. A working prototype of the ZX Microfloppy is due for completion about now, and it will probably be very soon that more details of the ZX-82 will appear. Meanwhile, work is still continuing between ICL and Sinclair Research on the new digital terminal using Sinclair's flat-screen technology.

One thing that is certain about the ZX-82 is that it will use a similar language to the ZX-81. Back in December, Clive Sinclair was quoted as saying "... we believe our language (Sinclair Basic) now merits serious consideration ... as the 'standard' ... ". Does it use the same cassette format? Can I use my ZX-81 add-ons with the ZX-82?

Only one man knows the answers to these questions, and he is keeping his mouth firmly shut at the moment.

Let's now look into our crystal ball to see if Clive has anything planned on the software front.

Clive at one time sold his software in Smiths but because of a 'high proportion of returns' Smiths did not re-stock after Christmas. That rebuff certainly stung Clive, as he is as aware as anyone that there is gold in that-there software.

There seem to be two main options open to him. Either to develop the software within his organisation or 'get into bed with' an established software company. He does not appear to have the resources available to develop his own software and a thorough examination of our crystal ball shows Clive in deep conversation with more than one software company and that a deal could be imminent for new ZX software.

There are, however, two stumbling blocks. One is the name under which the product would be marketed. Respected companies which have been or are about to be given the Smiths seal of approval would want to cash-in on their success and continue to market under their own names. Clive would probably want the products to carry only the Sinclair tag.

Second, the software companies might well be afraid that Sinclair has once and for all blotted his copybook with Smiths as a result of his not-very-successful first attempt, thereby preventing any chance of rich pickings in the high-street stores.

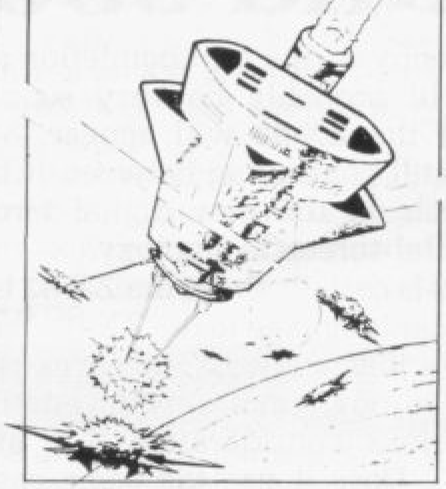
Neither of those problems is insurmountable, however, so we would not be in the least surprised if we hear an announcement from Clive in the not-too-distant future that he is to start selling some new software.

LEADERS IN COMPUTER GAMES

FIRST CHOICE FOR ZX : SUPPORT :

ZX-81

ZX-80



QS DEFENDER.
UP – DOWN – THRUST – FIRE
First and only full screen display. Software to drive QS SOUND BD. Moving Planetary surface. Up to 84 fast moving characters on screen at once. On screen scoring. Ten missiles at once. Increasing attack patterns. Requires 8K ROM, and 4K min of RAM. **£5.50.**



QS INVADERS.
LEFT – RIGHT – FIRE
13×7 INVADERS; High score; 3 levels of play; RND saucers; Bonus base; Drives Sound bd. & CHRS bd. Requires 7K RAM, 8K ROM+Slow. **£5.50.**

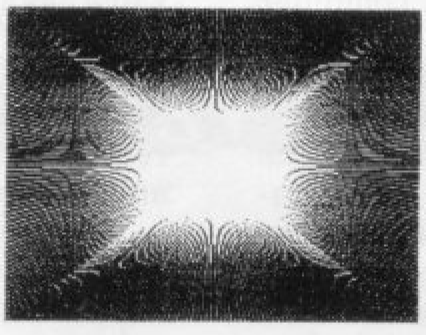


QS ASTEROIDS
LEFT – RIGHT – THRUST – FIRE
Software to drive QS SOUND BD. Multiple missiles firing in 8 directions. On screen scoring. Increasing number of asteroids. Full mobility of ship to all areas of the screen. Two asteroid sizes. Bonus ship at 10,000 points. Requires 8K ROM, 4K min of RAM + SLOW function. **£5.50.**

QS SOUND BD.
A programmable sound effects board using the AY-3-8910. 3 TONES; 1 NOISE; ENVELOPE SHAPER: + TWO 8 BIT I/O PORTS. Easily programmable from BASIC, the AY chip does most of the work leaving your computer free for other things. Signal O/P via 3.5 mm Jack socket Ports O/P via a 16 pin I.C. Socket. **£26.00.**

QS CHRS BD./
A programmable character generator giving – 128 SEPARATELY PROGRAMMABLE CHARACTERS. ON/OFF SWITCH. 1K ON BOARD RAM. Enables creation and display of your own characters to screen or printer. Demo cassette of fast machine code operation routines and lower case alphabet included. See below for ZX PRINTER listing. **£26.00.**

QS - LOWER CASE
abcdefghijklmnopqrstuvwxyz



QS HI-RES BD.
A Hi-res graphics board giving – 256×192 PIXELS. 6K ON BD. RAM. SOFTWARE SELECT/DESELECT. MIXED TEXT AND GRAPHICS. 2K ON BOARD ROM. Resident fast machine code graphics software (in ROM) provides the following HI-RES Commands. – MOVE x, y; PLOT x, y; DRAW x, y; BOX x, y; UP; DOWN; LEFT; RIGHT; PRINT A$; SCROLL; BLACK; WHITE CLEAR COPY. See side for ZX PRINTER listings using COPY. **£85.00.**

QS 3K RAM Bd.
An extremely reliable static RAM Bd. which combines with the computer's memory to give 4K total. Plugs direct in to the rear port on your ZX Computer. **£15.00.**

QS MOTHER BOARD BD. & QS CONNECTOR.
A reliable expansion system allowing a total of any RAM pack plus two other plug in boards to be in use at once. On board 5V regulator drives all external boards. Fitted with two 23 way double sided edge connectors. Connector is 2×23 way edge conns soldered back to back. Expansion can operate in two ways – (1) COMPUTER ↔ CONNECTOR ↔ Any QS add on bd. (but no extra RAM pack). (2) COMPUTER ↔ CONNECTOR ↔ MOTHER BD ↔ ANY RAM PACK. (2 bds to fit in mother bd.) Mother board **£12.00** Connector **£4.00.**

Special offers & news

(1) QS Mother bd. + connector + CHRS bd. + The special Graphics version of **ARCTIC COMPUTING'S ZX CHESS 11. £45.00.**
The strongest chess program with 7 levels of play.

(2) QS MOTHER BD + CONNECTOR + either SOUND or CHRS bd. **£40.00.**

We will be at the following shows . . . Come and see us . . .
THE COMPUTER FAIR, Earls Court, 23rd to 25th April
3rd ZX MICROFAIR, Central Hall, Westminster.
30th April & 1st May



ALL PRODUCTS FULLY GUARANTEED.
QUICKSILVA: 95, UPPER BROWNHILL RD. : MAYBUSH : SOTON : HANTS : ENGLAND.
Please state Type of machine, Which ROM, Memory size, when ordering.

From black boxes to boards ... to-the-point assessments of hardware now on the market

To save programming time

A PIECE of hardware not intended to fit on to the ZX-81, Print 'N' Plot Jotter is a pad of paper which consists of two grids, one for plotting Pixel graphics and one for printing Alphanumeric characters. They are intended for the programmer who wants to improve his programs and save time by planning his displays on the screen before PRINT AT X: Y: ALPHANUMERIC or PLOT X; Y a pixel.

The Print 'N' Plot Jotter is also useful to use with the Sinclair printer, as was shown at the ZX Microfair, by the firm producing an aeroplane plotted on paper more than one foot long. A polyester film version is also available for transferring book or magazine pictures to the ZX-81.

The Print 'N' Plotter Jotter costs £3.50 for 100 sheets and the film £2.25. Both are available from Butler Currie and Hook, 19 Borough High Street, London SE1 9SE.

Keyboard with a difference

HAVEN HARDWARE has gone one step further than producing a real keyboard and produced a circuit which will make any key on the keyboard repeat after one second. It will allow you to cursor right a number of times, back to a mistake made in a INPUT line, by holding-down two keys. It is available on the printed circuit board for the Haven keyboard or can be attached to another keyboard by soldering it to the ZX-80 or ZX-81.

The keyboard module costs £2.50 as a kit for another keyboard or £2.50 for the components to mount on to the Haven keyboard.

Haven Hardware is at 4 Asby Road, Asby, Workington, Cumbria C4 14 4RR.

Resolution rise for good graphics

QUICKSILVA has produced a high-resolution graphics board which will produce BBC-type plotting of lines, boxes and other dot graphics. The ZX-80 and ZX-81 'chunky graphics' with a maximum



High-res graphics

resolution of 43 × 64 pixels is replaced by a screen offering a resolution of 192 × 256.

Each dot on the screen can be addressed by an X/Y co-ordinate in a REM statement, which may have more than one command in it. All the USR routines are stored in a 2K ROM mounted on the board, so no machine code REMs are required.

Drawing lines, boxes, or only dots can be done in either black or white, while clearing the screen requires writing-over the dots with the background colour. Alphanumeric characters can be used and there are commands to clear the screen in black or white.

The board costs £85 inclusive and Quicksilva is at 95 Brownhill Road, Maybush, Southampton.

FIZ into floppy action

CALLED a FIZ—Floppy-disc Interface for the ZX-81—the Macronics floppy disc provides a standard 5¼in. floppy disc drive, software in a 2K ROM and a motherboard in the same unit.

The disc will provide 43K of storage which can be LOADed at a rate of 8K in 22 seconds. The disc has 34 tracks and 10-128 byte records on each track, for storing data or programs. The commands are given to routines stored in ROM, so that no RAM is wasted and all the disc commands are written to be used from Sinclair Basic.

The motherboard provides all the power for the system, including ZX-81, and interface cards to a paper printer will be available soon. There is also the possibility of a networking card soon.

FIZ costs £303.03 inclusive and is available from Macronics, 26 Spiers Close, Knowle, Solihull, West Midlands B93 9ES.

Cheaper printer paper

IF YOU run out of paper, what do you do? Do you panic and send next time for twice as much as you need from Sinclair? Now there is an alternative supply which should be quicker and cheaper than Sinclair.

Silicon Tricks can supply five rolls of electrostatic paper, the same size as Sinclair paper, of similar quality. The price for the five rolls is £7.50, whereas the Sinclair cost is £11.95. Ten rolls cost even less per roll, at £14.50. They are available by mail order only. Silicon Tricks, 2-4 Chichester Rents, Chancery Lane, London WC2 1EJ. 01-603 6074.

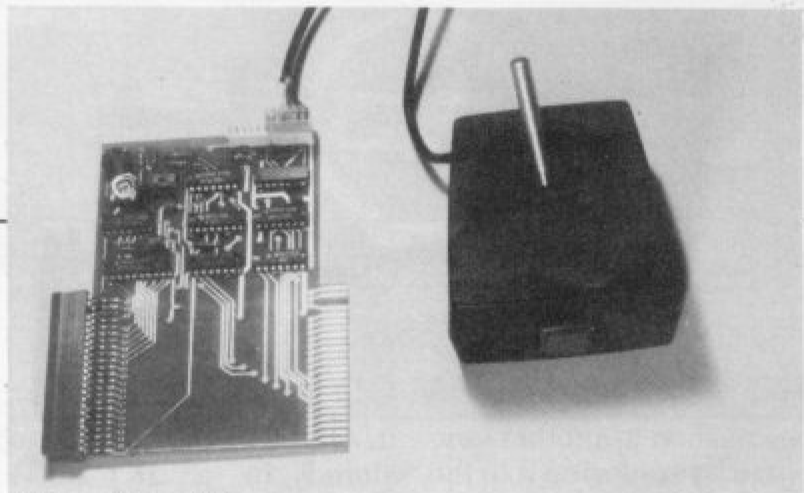
Building memory by blocks

A RAM extension kit is expandable in the form of 2K blocks up to a maximum of 16K, as and when you need it. It requires no soldering connections and fits in the ZX-81 beneath the keyboard.

If you later decide to buy an external 16K pack, the internal RAM can be altered to fit into the next 16K section, so that you can have continuous Basic memory up to a total of 32K.

(continued on page 8)





High quality joysticks

(continued from page 7)

There are two kits available, 2-8K RAM costing £8.50 and 2-16K at £9.50. Details are available from East London Robotics (Electronics), Finlandia House, 14 Darwell Close, East Ham, London E6 4BT. 01-471 3308.

Artic comes in with Forth

FORTH, the language in which you can build a vocabulary of your own commands, can now replace Basic on your ZX-81. This version of Forth resides in EPROM like the Sinclair Basic and is therefore available when switching-on the power, with no LOADing problems.

Forth programmers write the commands in the form of subroutines, which are then COMPILED into machine code, so that they run faster than their Basic equivalent.

Forth is available from Artic Computing, 396 James Reckett Avenue, Hull, North Humberside HU8 0JA.

The joy of real joysticks

THERE ARE now proper joysticks with a smooth action and fire button, like the expensive computer games machines, available for the ZX-81. The joystick is attached to the ZX-81 via a controller board which plugs into the back of the ZX-81 and has a connector on the back for the 16K RAM pack printer.

The joysticks are used by selecting the movement to be tested UP/DOWN, LEFT/RIGHT and then using the PEEK command to see the position of the joystick. That can give a result between 27 and 114 but it can be altered on the board.

All the instructions can be in Basic or machine code and the cost of the joysticks is £9.60 each, with the controller board costing £129.80. *Space Invaders* and a *Maze* game are already available from Micro-Gen, 24 Agar Crescent, Bracknell Berkshire. 0344-27317.

Experiment with blank boards

BLANK printed circuit boards are now available for experimenting with the expansion bus or motherboard of ZX machines. They have a gold-plated edge connector on them, in which only a slot for the keyway needs to be cut. As they are coated on both sides in copper, you can design your own circuit to use the ZX-81 as a controller of devices and then etch away the copper at home.

That leads the way to even more products for the ZX machines, as the cost of making experimental boards falls.

Cambion Electronics produces the board for £3 and can be reached at Castleton, Sheffield S30 2WR.

As easy as drawing on paper

THE LATEST device from RD Laboratories for its 8100 system is a light pen which, when used with the slow mode of the ZX-81, can impact with the program on the screen. That means that drawing pictures on the screen, using alphanumeric characters, or plotting using pixels is as easy as drawing them on a piece of paper.

It can also be used to select from a menu of items, as in a multiple-choice question, without making a mistake by pushing the wrong button. All that can take place using Basic or machine code.

The light pen system consists of a Micro-Mum (RD8100) motherboard, light pen and access unit (RD8180), plus a free demonstration tape of software. The cost is £49.50 from RD Laboratories, 5 Kennedy Road, Dane End, Ware, Herts SG12 0LU. 0920-84380. It is one of the many modules available for the system.

Redditch sticks with Sinclair

REDDITCH Electronics will supply everything from a ZX-80/81 edge connector to a programmable timer-counter oscillator on one board. It can also supply motherboards, keyboards, A/D and D/A converters and power supplies, as well as books. The boards are available in kit or ready-built form.

The firm knows Sinclair Research equipment well, as it was one of the few which supported the first Sinclair effort in computing, the MK-14, long after Sinclair had abandoned it.

Redditch Electronics is at 21 Ferney Hill Avenue, Redditch, Worcs B97 4RU. 0527-61240 — 0900-1230, 1400–1700 hours.

Plugs into the edge connector

A BLACK BOX which plugs into the edge connector of the ZX-80 or ZX-81 giving 5K of Basic memory and an input/output sort is known as the 'P' pack, the basis of the DCP system. It is accessible from Basic via the PEEK and POKE commands, and the port is memory-mapped.

The input/output section can be attached to two other modules, one at a time, to give A/D-D/A conversion or larger current-handling capacity via replays. The D/A pack is known as the 'A' pack and the relay as the 'C' pack. The price of the 'P' pack is £37.95, 'A' pack costs £19.95 and 'C' pack £29.95. They are all enclosed in tough black boxes and, like the 'P' pack, contain instructions for use with other circuits. A speech talker will soon be available.

DCP is at 2 Station Road, Lingwood, Norwich, Norfolk N13 4AX. 0603-712482.

Memotech's New Memory System for the ZX81

It grows as you progress





Memopak 16K Memory Extension - £39.95 incl.VAT

It is a fact that the ZX81 has revolutionised home computing, and coupled with the new Memopak 16K it gives you a massive 16K of Directly Addressable RAM, which is neither switched nor paged. With the addition of the Memopak 16K your ZX81's enlarged memory capacity will enable it to execute longer and more sophisticated programs, and to hold an extended database.

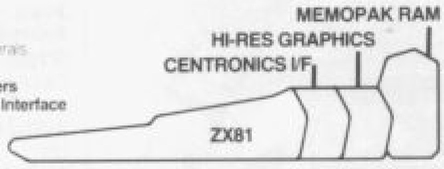
The 16K and 64K Memopaks come in attractive, custom-designed and engineered cases which fit snugly on to the back of the ZX81, giving firm, wobble-free connections.

See below for ordering information.

Coming Soon...

A complete range of ZX81 plug-in peripherals

Memotech Hi-Res Graphics
Centronics Interface and Software Drivers
Memotech Digitising Tablet RS232 Interface



All these products are designed to fit 'piggy-back' fashion on to each other, and use the Sinclair power supply. WATCH THIS SPACE for further details. We regret we are as yet unable to accept orders or enquiries concerning these products – but we'll let you know as soon as they become available.

How to order your Memopak.

By Post: Fill in the coupon below and enclose your cheque/P.O./Access or Barclaycard number.

By Phone: Access/Barclaycard holders please ring Oxford (0865) 722102 (24-hour answering service).

Memopak 64K Memory Extension - £79.00 incl.VAT

The 64K Memopak is a pack which extends the memory of the ZX81 by a further 56K, and together with the ZX81 gives a full 64K, which is neither switched nor paged, and is directly addressable. The unit is user transparent and accepts basic commands such as 10 DIM A(9000).

BREAKDOWN OF MEMORY AREAS

0–8K . . . Sinclair ROM

8–16K . . . This section of memory switches in or out in 4K blocks to leave space for memory mapping, holds its contents during cassette loads, allows communication between programmes, and can be used to run assembly language routines.

16–32K . . . This area can be used for basic programmes and assembly language routines.

32–64K . . . 32K of RAM memory for basic variables and large arrays.

With the Memopak 64K extension the ZX81 is transformed into a powerful computer, suitable for business, leisure and educational use, at a fraction of the cost of comparable systems.

Unique 3 month trade-in offer!

When your programming needs have outgrown the capacity provided by 16K RAM, and you find it necessary to further extend your ZX81's capacity, we will take back your 16K Memopak and allow a discount of £15.00 against your purchase of our 64K model.*

**We reserve the right to reject, for discounting purposes, units which have been either opened or damaged in any way.*

Please make cheques payable to Memotech Limited

Please debit my Access/Barclaycard* account number

____

**Please delete whichever does not apply.*

SIGNATURE ____________ DATE ________

Please send me:

	Quantity	Price	Total
16K RAM, Assembled		£39.95	
64K RAM, Assembled		£79.00	
		Postage	£2.00
		Total Enclosed	

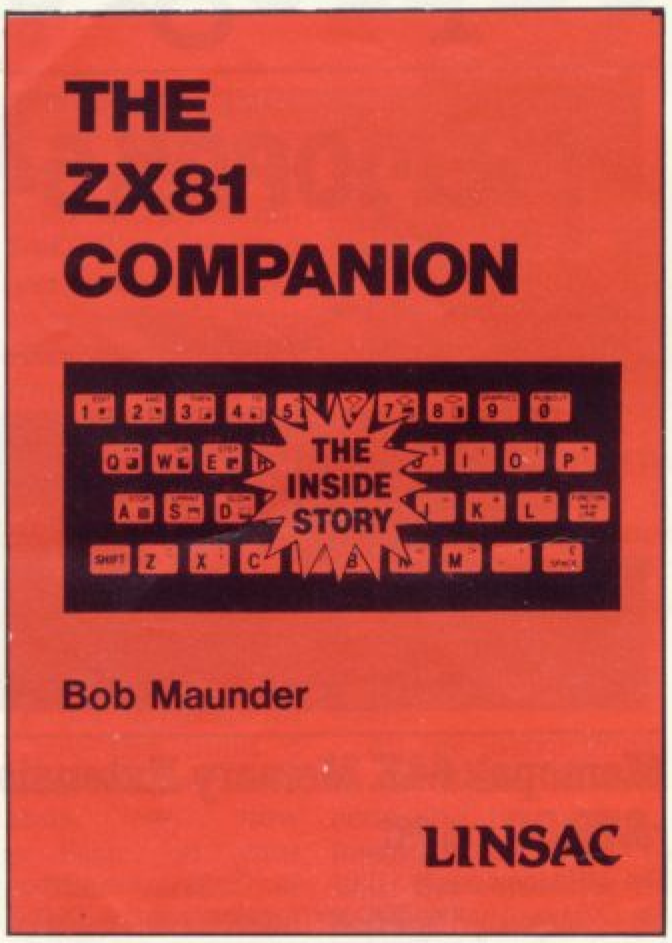
NAME ____________ ADDRESS ____________

SU2

We want to be sure you are satisfied with your Memopak – so we offer a 14-day money back Guarantee on all our products.

Memotech Limited, 3 Collins Street, Oxford OX4 1XL, England Telephone: Oxford (0865) 722102/3/4/5

"THE BEST ZX81 BOOK"



If you have a Sinclair ZX81 and want to use it to its full potential then, as the experts have all agreed, this is the book for you. It contains detailed guidelines and documented programs in the areas of gaming, information retrieval and education, as well as a unique listing of the 8K ROM for machine code applications.

'Far and away the best ... once again Linsac has produced the book for the serious end of the market'. – *Your Computer, November 1981*.

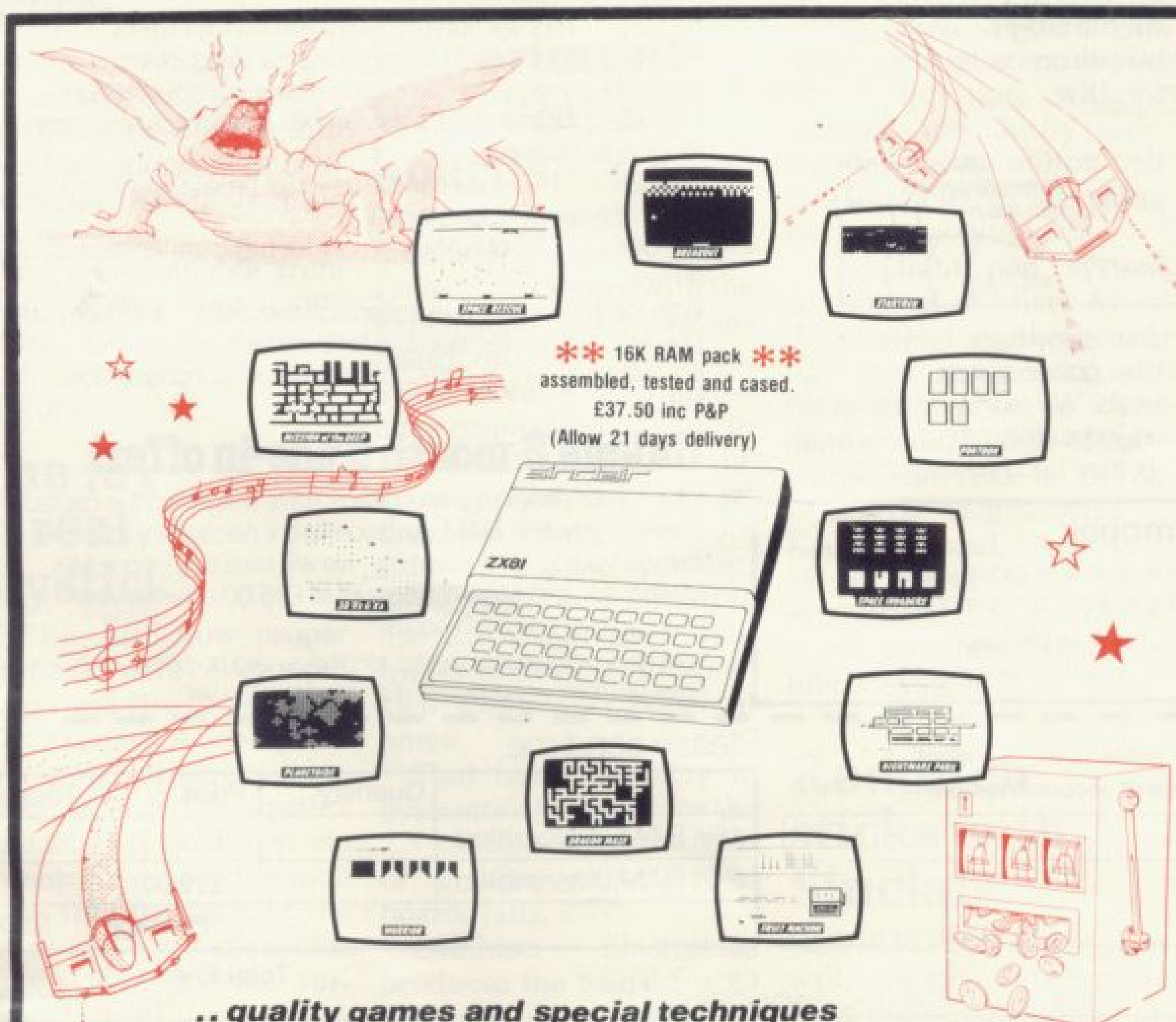
'*The ZX81 Companion* is a most professional product ... with many good illustrative programs, tips and warnings'. – *Education Equipment, October 1981*.

'Bob Maunder's attempt to show meaningful uses of the machine is brilliantly successful ... thoughtfully written, detailed and illustrated with meaningful programs ... To conclude – the book is definitely an outstandingly useful second step for the ZX81 user'. – *Educational ZX80/81 Users' Group Newsletter, September 1981*.

Send your cheque for **£7.95** (includes UK p&p) to:

LINSAC (SU) 68 Barker Road, Linthorpe, Middlesbrough TS5 5ES.

ISBN 0 907211 01 1 Price **£7.95**



✱✱ 16K RAM pack ✱✱
assembled, tested and cased.
£37.50 inc P&P
(Allow 21 days delivery)

.. quality games and special techniques
the widest range available from one supplier!

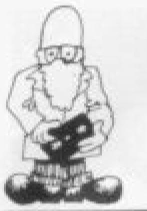
Music	1K	£2.95
Music	2–16K	£3.95
Nightmare Park	14K	£4.95
High Res. Graphics	16K	£3.95
Space Invaders	1K	£4.95
Space Invaders (13)	3K	£5.95
Breakout (B1)	1K	£3.95
Dragon Maze	16K	£4.95
Planetoids	16K	£3.95
Scroll/ Rolling Riter	1–16K	£2.95
Life	16K	£3.95
Startrek	16K	£4.95
Mission of the Deep	16K	£5.95
Fruit Machine and Pontoon	16K	£2.95
Space Rescue	16K	£3.95
Warrior	16K	£4.95
3D "O" & "X"s + Connect Four	16K	£5.95
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More software delights for your machine



Making maths easier

A PROGRAM which appears to defy the rules of mathematics has been added to the Video Software range of 'serious' software for the ZX-81. Called Video-Index, the maths-defying element is the fitting of 57,000 characters of data in a 16K memory, which is achieved by an ingenuous technique whereby duplications of descriptions are detected and eliminated.

Written largely in machine code for speed, Video-Index provides a technique for using the ZX-81 to build a catalogue or index which can be stored on cassette and re-used. The program, which is supplied with a demonstration index of computer magazine articles about the ZX-81, costs £9.95 and can be obtained from Video Software, Stone Lane, Kinver, Stourbridge, West Midlands DY7 6EQ.

Ten games on one cassette

A CASSETTE with 10 games to run on the ZX-81 with 16K RAM offers a wide choice. Recorded on both sides, the cassette, offers all 10 games twice but in a different order, depending on the side of the cassette used.

The games include board and card games such as *Othello* and *Pontoon* and combat games such as *Laser Bases*.

It also offers *Rectangle*, where the object is to form rectangles with a bigger total area than those formed by the computer. The skill in this game is to form rectangles which are fairly big without having



them blocked and at the same time to use your points to block the rectangles the computer tries to make.

The user and the computer take turns to choose a point, neither knowing which points the other has chosen until one calls 'show'. The games, assembled on the Cassette Two which costs £5, are available from the Michael Orwin ZX-81 Software Catalogue, 26 Brownlow Road, Willesden, London NW10 9QL.

Orwin is putting together Cassette Three, which includes a game called *Princess of Kraal*, wherein the princess has to be rescued from a dungeon six levels deep and where you, the rescuer, having chosen the level of difficulty, time period of the game and type of maze, find your way to the correct room via perils including rockfalls, monsters and floods. There are some bonuses on the way but the princess is undoubtedly difficult to find.

Galaxians invade W H Smith

A VERSION of *Galaxians*, the popular arcade game, is now available to ZX-81 users through W H Smith. Called predictably *ZX-Galaxians*, it requires 16K of RAM and offers personalised high-scoring routines, swooping attackers, full explosions and continuous status reports.

The originators, Artic Computing, believe that it was chosen by W H Smith because it is exceptional. Written in machine code, the game runs smoothly with no flicker on the screen, mostly because it uses pixels which split the characters in two.

W H Smith is selling *Galaxians* on a cassette at £4.95, which includes a dungeons and dragons random adventure game, *Swords of Peace*. Artic Computing can be contacted at 396 James Reckitt Avenue, Hull, North Humberside.

Helping with machine code

AN EFFECTIVE tool for the speedy development of Z-80 machine code routines entails a number of procedures which will facilitate loading, as well as check and query errors. Developed by Michael Cox Information Services, the M/C Load and M/C Edit programs form a suite which retails at £8.90 and is intended for use with a fully-debugged machine code program.

The procedures require you to draft your routine manually, listing Assembler mnemonics and, for the instruction codes, the relevant hex code. Using M/C Load, you then enter hex and decimal arguments to derive the ZX-81 code, which is added to the manual draft.

Using M/C Edit, the ZX-81 code is entered together with break-points as required. So, when the routine is proved, the M/C Load program is used to enter the finished routine in memory.

(continued on page 12)





(continued from page 11)

MCIS can be contacted at 62 High Road, North Weald Bassett, Essex CM16 6BY.

Banking on a new system

A SYSTEM which enables you to keep detailed records of bank transactions and thus produce a better statement than that of your bank can is available to users of the ZX-81 16K RAM system. *Personal Banking System* offers facilities such as automatic posting on the statements of all standing orders due monthly, quarterly, six-monthly or annually and

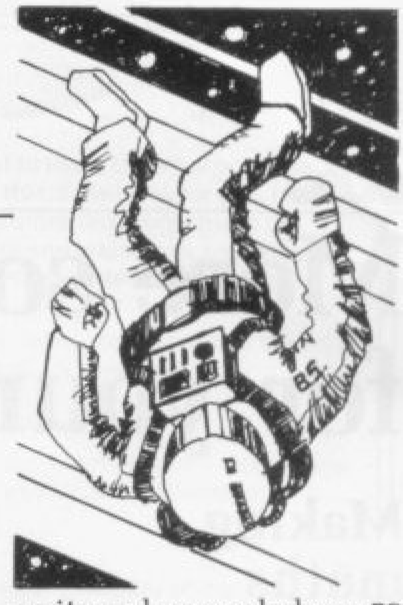


incorporates a machine code load/save feature which permits the storing of transactions in data files on cassette, separate from the program. That facility saves and loads the program varibles only.

The *Personal Banking System* is available for £9.95 inclusive of cassette and user manual from J P Gibbons 14 Avalin Road, Orpington, Kent BR6 9AX.

Dangers from a starship

ANOTHER GAME for the soon - to - be - released Michael Orwin Cassette Three requires 16K of memory and will be one of 10 or so games on the cassette. *Starship Trojan* puts you in the unfortunate position of being the only survivor on a starship which has been badly damaged in a meteor storm. It is satisfactory to be a survivor but you have to repair the damage to the ship before the total air level drops below 3,000



units and you only have 70 hours for repairs before your next inter stellar jump.

There are other dangers lurking but at least you are armed with lasers and stun grenades. The game promises to be at least as absorbing as previous Orwin cassettes and will be available from Michael Orwin, 26 Brownlow Road, Willesden, London NW10 9QL.





Your queries numbers ans

In this column Andrew Hewson, author of *Hints & Tips for the ZX-80* and *Hints & Tips for the ZX-81*, answers your questions on hardware and software for Sinclair ZX

I HAVE had many letters in recent weeks asking about the methods used by the ZX-81 to store and display numbers and so I have devoted this month's column to the topic.

The machine uses one of three methods, depending on the context. The first is the floating point method which is used for all Basic variables and all calculations involving Basic variables. All numbers held using the technique occupy five bytes each. The second method is used internally by the Z-80 microprocessor which drives the ZX-81 and can be used for whole numbers only.

Each number occupies only two bytes and a variation of the method is used to store the line numbers at the beginning of each Basic program line. To communicate to the user the ZX-81 uses a third method, the character form, in which each decimal digit, and the decimal point, occupies one byte each. All the questions this month concern the floating point method. The first is from James Tucker of Solihull, who asks:

What does floating point arithmetic mean? Why use it? Would it not be easier to use the decimal system?

The use of floating point arithmetic implies that numbers are stored and manipulated as a mantissa, which contains the digits in the number, and an exponent, which indicates the position of the decimal point. It is relatively easy to convert decimal numbers into a decimal floating point representation and some calculators can display decimal numbers in that form. The calculator manufacturers refer to the form as scientific notation.

The great advantage of scientific notation is that very large numbers, or numbers which are very close to zero, can be written approximately using a limited number of digits. Thus a calculator which can display only eight digits at a time can display a number larger than 99,999,999 using scientific instead of ordinary notation.

For example, the distance from the earth to the sun is about 5,892,480,000,000 inches. Thirteen digits are required to write the number in ordinary notation but when it is re-written in its scientific form as 5.89248×10^{12} only eight digits are required—neglecting the × 10 which is common to all numbers written in that way. The mantissa is 589248 and the exponent is 12.

The exponent, by the way, means "imagine that the decimal point is to the right of the left-most digit of the mantissa—i.e., between the 5 and the 8. Now move the point 12 places to the right, filling spaces with zeros if necessary".

The scientific form, of course, is not accurate because only eight digits, of which six only are in the mantissa, are allowed, whereas in the ordinary form 13 are available, although in our example the extra digits are all zeros.

We count in tens and so calculators display numbers in decimal for our convenience. Digital computers count in binary as explained in chapter 24 of the ZX-81 Basic programming manual but the principle of floating point binary representation is the same as that of decimal scientific notation. The ZX-81 uses a string of seven zeros and one for the exponent—i.e., one byte with one bit reserved for the sign of the exponent—and a string of 31 zeros and ones for the mantissa—four bytes with one bit used for the sign of the mantissa.

Floating point arithmetic is used because it enables a large range of numbers to be stored in five bytes with only a small loss in accuracy.


Andrew Hewson

Numbers as big as 10^{38}—one followed by 38 zeros—can be stored, although only the first nine digits or so are accurate. If integer arithmetic were used, then the biggest number which could be stored in the same space would be 1,099,511,627,776 but all 13 digits would be accurate.

How are numbers stored in the ZX-81? Please explain how the five-byte representation of a number is obtained, writes Peter Stern of London.

The following program prints the floating point form of a number entered by the user at line 20:

```
10 PRINT "ENTER A NUMBER"
20 INPUT I
30 PRINT,,"THE ZX81
REPRESENTS":I:"BY"
40 FOR J=1 TO 5
50 PRINT PEEK (PEEK 16400+256*
PEEK 16401+J);" ";
60 NEXT J
70 PRINT
80 PAUSE 500
90 CLS
100 RUN
```



...es on storing ...nswered

computers. Please address your problems, queries and comments on the computers to Andrew Hewson, Helpline, 7 Grahame Close, Blewbury, Oxon.

The ZX-81 stores the values of all Basic variables in the variables areas and the address of the beginning of the variables area is held in VARS at locations 16400 and 16401—see chapter 28 of the ZX-81 manual. Thus the loop at lines 40 to 60 prints the contents of the five bytes which hold the floating point version of the number entered.

The first of the five bytes is the exponent, E, and the remaining four bytes, A, B, C, D represents the mantissa. If the original number is positive, A lies in the range 0 to 127. If it is negative, A lies between 128 and 255.

The following program re-contructs a number from its Sinclair floating point form:

```
10 PRINT "ENTER THE
EXPONENT AND THE FOUR
NUMBERS OF THE MANTISSA,
ALL ENTRIES TO LIE BETWEEN 0
AND 255 INCLUSIVE"
20 INPUT E
30 INPUT A
40 INPUT B
50 INPUT C
60 INPUT D
70 INPUT , ,"EXPONENT = "
,E,"MANTISSA = ",A,,B,,C,,D
80 PRINT , ,"THE NUMBER = ";(2*
(A<128)-1)*2**(E-160)*(((256*
(A+128*(A<128))+B)*256+C)
*256+D)
```

Try those two programs for a variety of numbers. You will see that the exponent is about 128 for numbers close to 1 and -1; that numbers close to 0 have small exponents; and that large positive and large negative numbers have large exponents.

It is also noticeable that the value of the fourth byte, D, has little or no effect on the value printed by the second program. In computer jargon D is called the least significant byte. The ZX-81 prints results to eight decimal figures at most, rounding the result if necessary, although calculations are made to somewhat greater accuracy.

The final question is from Roger Hurr of Coventry. He writes: **I am writing a program to test my son's arithmetic but I have found that my ZX-81 sometimes gets the answer wrong. I know that some early ZX-81 ROMs made an eror with the square of 0.25 but my machine does not make that mistake. Is this another bug?**

He sent his program and it became apparent quickly that the fault lay with his program and not with his ZX-81. The routine which was at fault set a problem in division and then compared the user's reply to the result calculated by the ZX-81. Unfortunately for him the routine often rejected correct replies.

It is often impossible to convert a decimal number exactly to a binary floating point number and that was the source of Roger's problem. An analogous difficulty can occur when converting some fractions into decimal—we are all familiar with the fact that $\frac{1}{3}$ cannot be written as an exact decimal. The program was rejecting the user's reply even when it differed by only a tiny amount from the calculated result.

The following program asks you to enter a number, divide it by 10 and enter the result. It then prints the floating point representation of your result and its own result for the same calculation. If you run the program a few times you will see that your answer and the answer produced by the ZX-81 often differ by one in the least significant digit of the mantissa.

```
10 LET N = 500
20 CLS
30 PRINT "ENTER A NUMBER"
40 INPUT I
50 PRINT , , "YOU ENTERED" ;I
60 PRINT , , "DIVIDE" ;I; BY 10"
70 PRINT "ENTER THE RESULT"
80 INPUT J
90 PRINT , , "YOU ENTERED" ;J
100 LET K = I/10
110 IF ABS (K - J) < .0001*K THEN
GOTO 170
120 PRINT , , "WRONG"
130 PRINT I; "DIVIDED BY 10 DOES
NOT EQUAL" ;J
140 PRINT "TRY AGAIN"
150 PAUSE N
160 RUN
170 PRINT , , "RIGHT"
180 PRINT I; "/10 = " ;J
190 PAUSE N
200 CLS
210 PRINT , , "THE ZX81
REPRESENTS" ;J; "BY"
220 LET M = 13
230 GOSUB 300
240 PRINT , , "AND" ;I; "/10 BY"
250 LET M = 19
260 GOSUB 300
270 PAUSE N
280 RUN
300 FOR L = M TO M + 4
310 PRINT PEEK (PEEK 16400 + 256
* PEEK 16401 + L); " ";
320 NEXT L
330 PRINT
340 RETURN
```

If you wish to avoid problems of that nature then you should alter statements like

IF K = J THEN GOTO 170
to IF ABS (K - J) < .0001 * K THEN
GOTO 170

In the first case the program will jump to line 170 only if K and J are identical down to the last digit. In the second case, the jump will be made if the difference between K and J is less than .01 percent.



Filling a market need

I FIRST heard of your magazine at the ZX-Microfair but I thought it would just be two pages of old news for members of a user club. I am very pleased to find it on general distribution at such a reasonable price. The magazine seems to fill a market need, judging by the amount of ZX information which has been appearing in other magazines.

I feel there are three ways in which the magazine could be improved. First, the introduction of an advertisers' index in an easily-locatable part of the magazine. Second, how about having a small section on the old MK-14 ranging from a piece about what it was, to a regular hardware and software spot? Third, I find one of the most informative parts of computer magazines in the letters page and I hope you will introduce one.

The queries raised and ideas suggested through letters pages have often prompted me to try ideas I would never otherwise have thought of.

Hoping that you will maintain the same high quality.

William Nuttall
Lewes, E. Sussex.

●*As you can see, points one and three are now taken care of. We are still thinking about point two. What do other readers think?*

Not just propaganda

I HOPE that in future you will not merely publish propaganda for Sinclair Research, because although the ZX-81 is undoubtedly an excellent machine, it has its faults, and the Sinclair organisation still leaves something to be desired.

An advertisers' index at the back of the magazine would be very helpful. I wish you every success in your new venture.

A. Maclure,
Witham, Essex.

●*See page 65 for the advertisement index.*

Monopoly information

I EXPRESS my thanks for the information relating to ZX-81 *Monopoly*.

We were pleasantly surprised this morning to find an order in our post for it. As you are probably aware, it is very unusual to obtain direct response from a press release, especially so early after the publishing date.

We wish you luck with *Sinclair User* and enclose information for your next issue. We feel sure our investment will be rewarded with an increase in turnover.

We would ask you if possible to advise your readers that ZX-81 *Monopoly* requires 16K RAM to function. We ask it because it was omitted from your editorial and we would rather not take orders which eventually will lead to disappointment for the purchaser.

Thank you for your assistance and good luck.

Derek Tidman,
Work Force,
Luton, Beds.

Discipline and guidance

ONLY a week after I bought a ZX-81 and 16K RAM, your welcome magazine appeared in the newsagents. Excellent timing, if I may say so.

It is obviously early days for you but I hope that your reviews of hardware and software will be frank and critical, as well as giving praise where it is due. I realise that as a commercial enterprise you must keep a weather eye on advertising but the kind of discipline you could help impose can only be good for products and users—and for your circulation in the long run.

I look forward to future issues, and certainly wish you well. Meanwhile I wondered if you could give some guidance to help me resolve a programming problem?

To calculate hours worked during a week from data recorded on time cards, thus:

Data supplied

	Mon	Tue	Wed	Thu	Fri
arr.	0845	0900	0836	0905	0848
dep.	1310	1232	1238	1242	1303
arr.	1405	1340	1315	1358	1352
dep.	1705	1716	1648	1702	1654

To be adduced from data

Total	Total
	4414
6405	
	6850
8425	
A 14830	B 11304

A – B=3526=hours worked, in hours and minutes

T. E. Newman,
Worcester Park, Surrey.

●*Thanks for the compliments and we have sent your problem to Andrew Hewson. Hopefully he can provide a solution.—Editor.*

Watch out for

Phil Garrett tries to guide you through the world of adventure games in this the first of two fascinating articles on the subject

IF YOU enjoy delving into rat-infested dungeons, crawling through dimly-lit caves, and wandering round long-abandoned mine-workings, *Adventure* is for you. Your powers of memory, logic and patience are tested to the limit as you take life-and-death decisions in your search for fame and riches—all without leaving the comfort of your chair and with only one risk to your physical well-being. That is a severe headache after bashing your head against the wall then your latest seven-minute *Adventure* failed to load for the fifth time.

Adventure is a role-playing game, where after being told about your immediate environment, you can enter commands such as "Go west", "Take keys", "Throw knife". The computer will then provide an appropriate response, such as a new room description, "You missed", or some other message. You many encounter fabulous treasures, or perhaps only mundane objects, although they may, if used correctly, be the key to a still greater fortune.

You will probably need to make a map as you proceed to have some chance of re-tracing your steps to the entrance. Natural—and unnatural—hazards abound to prevent your escape, and it should take many delvings to discover all that an *Adventure* contains.

Computer *Adventures* are a surprisingly recent invention, the original having been written on a mainframe in 1976 by William Crowther and Don Woods at Stanford University in the U.S. It is a remarkable achievement when you consider that, until recently, Fortran, the language they used, had none of the string-handling facilities of Basic. Until two years ago, *Adventure* was strictly the preserve of computer professionals but the growth of micros has resulted in far wider use.

For this review of *Adventure* games for the ZX-81, I decided to look at every *Adventure* and Adventure-type game I could find. They vary a great deal, from the traditional descriptive type to real-time graphics games, so I have tried to judge each on its merits rather than compare one to another.

My employer told us recently to take *Adventure* off the computer at work, as we were running out of disc space. That being such an unreasonable instruction, I checked how much memory it used and found that the program and the data it required occupied more than a quarter of a million bytes. So, not surprisingly, all the ZX-81 games require 16K RAM packs.

The logical program to start with is the Abersoft *Adventure*, which attempts openly to pack as much of the Crowther and Woods' original into 16K as possible. As I was usually hopelessly lost in the maze in the *Adventure* at work, I was hoping that perhaps lack of memory had forced them to omit the maze from the Sinclair version. Not a chance; on the first attempt I went straight into it like a homing pigeon. The maze seems like quicksand; the more you struggle to escape the deeper you sink.

At that point I asked a friend who had acquired a good knowledge of the original *Adventure* to try from the beginning. She found that all the locations and objects were in the correct places, although the location descriptions were shorter. She even discovered a new area she had not entered previously.

The program is written in 13K of machine code and $1\frac{1}{2}$K of Basic, with more than 70 words which can be recognised as commands or objects, and a large number of locations. The game has been written with remarkable efficiency; location descriptions are built-up from individual words and phrases rather than stored *en bloc*. Being machine code, the program is very fast. At any time you can find your score and also save your current position on tape to continue later.

At £10, it is an expensive program but it is a remarkably good version of the original *Adventure* and well worth the money if you want to see what sparked the entire process.

Hilderbay is best known for being the "serious" software company, supplying business programs, but it has also forayed into the world of games and its *Gold* is a non-graphics 13K *Adventure* written in Basic. The object is to search for gold hidden in a network of caves and mines in the Yukon. All instructions are entered as a single letter, O for Open, G for Get, including references to objects such as Gold and Keys.

There is a sizeable network of logically-connected caves and rooms, although there are few objects. If you manage to find the gold, things change mysteriously and I have not been able to extract the goodies yet. At any time you can learn your score and there is an

the dragons!



added bonus if you manage to escape with the treasure.

Hilderbay is offering a 48K Memotech RAM pack to the person who achieves the highest score before the end of July but I do not think my 46 will be in the running.

At £8, with a word game included, *Gold* is reasonable value but could have been better with a few more objects—and word rather than letter input.

Bug Byte offers two Adventure-type games, the latest of which, *Dictator*, is a brilliant simulation of a banana republic; since it has no locations, no objects, and no movement of any kind, it is not an *Adventure* so I have not included it.

The other is *The Damsel and The Beast* which is a graphics-only 9K Basic game. The setting is an unlit palace of 35 rooms, containing a beast for bashing, a damsel for rescuing, and a few holes into which you can fall. That calamity should be

(continued on page 20)



(continued from page 19)

avoided by using the limited supply of torches available and you are also provided with some powerful clubs if you should wish to knock down a wall or kill a monster.

After being set-up randomly, the layout of the rooms does not change, so a logical approach is rewarded. Movement, and the use of clubs and torches, is by single-letter commands and the beast continues to move of its own accord while you decide what to do.

The game is not desperately fast and while in progress there is little to look at, although you are provided with a map of the events at the end. There is no score given but there are three levels of play and I found even the easiest of them difficult enough. It is not a game for *Space Invader* addicts but if logic and patience are your virtues, it is one to consider. It is on the expensive side at £6.50.

Quest from Serious Software is clearly based on the non-computer *Dungeons and Dragons* fantasy role-playing game, with the computer-man pitting his strength, constitution and dexterity against wandering monsters. It is a non-graphics game written in 12½K of Basic and is made up essentially of vampires, rats, werewolves and suchlike. If you can keep the fiends off your back for long enough there are potions, keys and other objects to be found and substantial amounts of treasure to be acquired.

Movement and fighting is done by single-key input, which can be confusing, since the same key may mean different things depending on what is happening around you, e.g., F may mean move Forward or Fire magic arrow. You can always ask for a status report and, if you can put together sufficient treasure, the delights of different levels are offered.

My reactions cannot cope with this one but at £5.95 for *Quest* plus a *Star Trek*, *Mastermind* and *Reversi* included, it is good value for the nimble-fingered.

Adventure from Simpson Software has its origins in the Crowther and Woods' original but is set in a mythical castle containing evidence of an estraordinary mixture of living beings—hobbits, dwarfs and pirates, among others. It is a non-graphics adventure with 25 logically-connected locations written in 11½K of Basic.

The method of processing instructions entered by the player is unusual; instead of checking for individual words as most *Adventures* do, the input string is compared in a large series of if-then statements. That makes it reasonably fast, but means there is a very limited vocabulary; e.g., you must refer to a Ming vase, not just a Vase. One



weak point—answers to Yes or No questions are not validated, so a NEWLINE stops the program.

There are plenty of treasures dotted about, a hidden lower level, and a maze into which you can fall. A score is kept, though my earliest attempts ended in negative scores. It is an unpretentious program, reflected in its price of £3. It would make a good introduction to anyone new to the concept of *Adventure* who wants to start with something reasonably simple.

Phipps Associates offers three complete *Adventures* on one tape, plus a detailed instruction program. All the games are written in 15K of basic and the first two are based on Trevor Toms' *Adventure*-writing program from his book *The ZX-81 Pocket Book*. Several months ago I typed-in the program and was impressed but I felt that it would be too difficult to use and that the range of locations and objects would be too limited. The Phipps tape proved me wrong.

Greedy Gulch is set in a Wild West ghost town with more than 20 locations, plenty of objects which have to be collected and used in a logical sequence, and a vocabulary of more than 50 words. It is not particularly fast—around 10 to 12 seconds to process instructions—but it has some graphics in the form of a simple but useful map. There is no score but to compensate there is a hint feature.

The second is the non-graphics *Pharaoh's Tomb* which has more than 60 locations, made possible by giving only short descriptions, and more than 20 objects. It runs slightly faster than *Greedy Gulch*, despite an even larger vocabulary, and has a score but no hint feature.

It shares with the first program some poor spelling, although Phipps Associates is by no means the only culprit where that is concerned.

Magic Mountain has witches, wizards and spells, and an assortment of mystified objects. It also has a maze which, as usual, I discovered very quickly. It took me a solid guilt-ridden hour of cheating to get out, despite using one of the hints available in the form of cryptic crossword-type clues. All three programs are excellent *Adventures* and at £5.95 complete they are undoubtedly the best value for money of all the *Adventures* I have seen so far.

Next month I will examine 12 more programs, including the three machine code *Adventures* from Artic.

Abersoft, 7 Maesafallen, Bow Street, Dyfed SY24 5BA.
Hilderbay Ltd, 8-10 Parkway, Regents Park, London NW1 7A.
Bug-Byte, 98-100 The Albany, Old Hall Street, Liverpool L3 9EP.
Serious Software, 7 Woodside Road, Bickley, Kent BR1 2ES.
Simpson Software, 21 Tuttles Lane West, Wymondham, Norfolk.
Phipps Associates, 99 East Street, Epsom, Surrey KT17 1EA.

Exploration into t

Stephen Adams demonstrates how free space on the Memory map has been utilised to make the ZX-81 more flexible.

WHEN Clive Sinclair designed his basic computer, it was to contain only three things within the memory map, the area where all the instructions to operate the computer are stored. The area is easily accessible by the Z-80A microprocessor and it is easy to program uses for it. The memory area is divided into 65535 locations (64K), by the 16 binary address lines (A0-A15) which are used to indicate the location at which the processor wants to look.

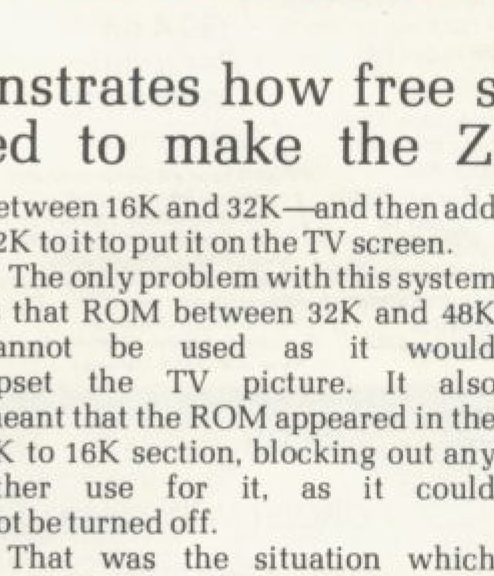
Sinclair required only a place to store a program (RAM), a place to hold instructions to operate the computer when it was first switched on (ROM) and a location in memory which would translate the TV picture. So he divided the Memory map into three sections, 0-16K for the ROM, 16K—32K for the program RAM and 32K—64K for the TV picture. That was done by using only the top two address lines A14 and A15, to tell which section was operating at the time.

This divided the Memory map into the four sections as shown in figure one with the ROM and RAM repeating itself again and again. The address line A14 is used to turn on the ROM when the condition is Binary 0 and when it is Binary 1 the RAM is turned on. The A15 Address line is used to operate the hardware which puts out the TV picture; it operates only when A15 is Binary 1.

As A14 can also change state from 0 to 1, while A15 is operating the TV hardware, the RAM can be used to store the screen display. The software in the ROM makes use of that fact and has only to pick up the address where the screen is—between 16K and 32K—and then add 32K to it to put it on the TV screen.

The only problem with this system is that ROM between 32K and 48K cannot be used as it would upset the TV picture. It also meant that the ROM appeared in the 8K to 16K section, blocking out any other use for it, as it could not be turned off.

That was the situation which existed in the ZX-80 and only internal modifications to the computer circuitry could sort it out. The only place left to put new devices produced by other manufacturers was to steal some of the RAM space



to fit in the new device. That was done by turning-off the RAM, operating a pin on the expansion port called RAM CS. That was included in the design, as some method was needed to turn off the 1K of internal RAM when the 16K RAM pack was fitted on the back.

That was because the 1K RAM was repeated through the whole of the 16K section and would get in the way when 16 separate 1Ks were installed instead. When the 16K Sinclair RAM was installed that was not possible as it not only blocked-off any connection to the expansion port by covering it, but also used the only free memory locations. It also did all of its address decoding inside the pack, so could not be turned off by operation the RAM CS line.

When Sinclair saw that there was a market for his computer and that other manufacturers wanted to use it as a basis for experimenting with computers, he re-designed it, giving greater flexability to the memory map. The result was the ZX-81.

The internal design was much the same as the ZX-80—figure one—but this time an extra connection in the expansion port had been put to good use. It was called the ROMCS pin and by operating it in the same way as the RAM CS pin, the RAM could be taken out of the Memory map. This was located on pin 23B on the expansion port and caused some chaos at first, as it was found that the first Sinclair attempt at more external memory, the 3K RAM pack, did not work the ZX-81. This was because inside the pack the pin was kept at a permenent Binary 0 and prevented the ROM from being turned on. The only solution to the problem was to cut the connection to the pin within the pack, leaving it unconnected to anything within the pack.

People could then from the outside of the computer, free some space in the memory map for their use. That was a great advantage, as many of the people who had bought the ZX-80 ZX-81 did not want to have to fiddle inside their precious computers with a soldering iron for fear of damaging them.

the memory map

It left many firms, which had cut their teeth in the ZX-80 with a vast market for adding additional boards to the ZX-81, which could greatly expand its flexibility and use. Many of the people who started in the field have now left their original jobs to work full-time producing add-on boards for the ZX machines.

It also led every manufacture to try to use the same areas for different uses. Also because the ZX customer was not willing to pay a great deal for any extras to his machine, costs had to be cut to fit the market. So they took a tip from Sinclair and reduced the amount of lines they used for addressing.

That meant that we had the same problem as previously, that one port covered more than one memory location; some cover up as much as 8K. That of course, means that when one device is using that area, no other devices can be used at the same address.

Figures two, three and four, show as many of the devices which I could

(continued on page 24)

Sinclair's Intended Memory Map.

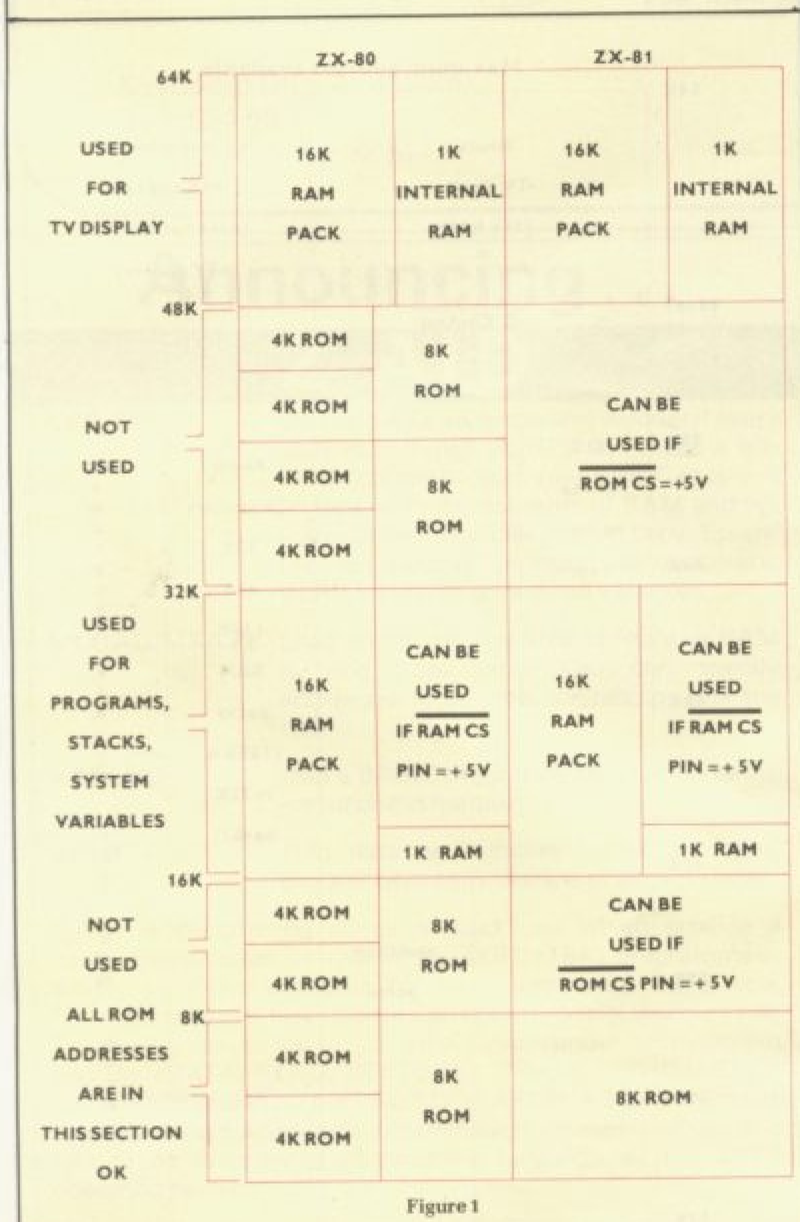


Figure 1

Memory Map O-16K

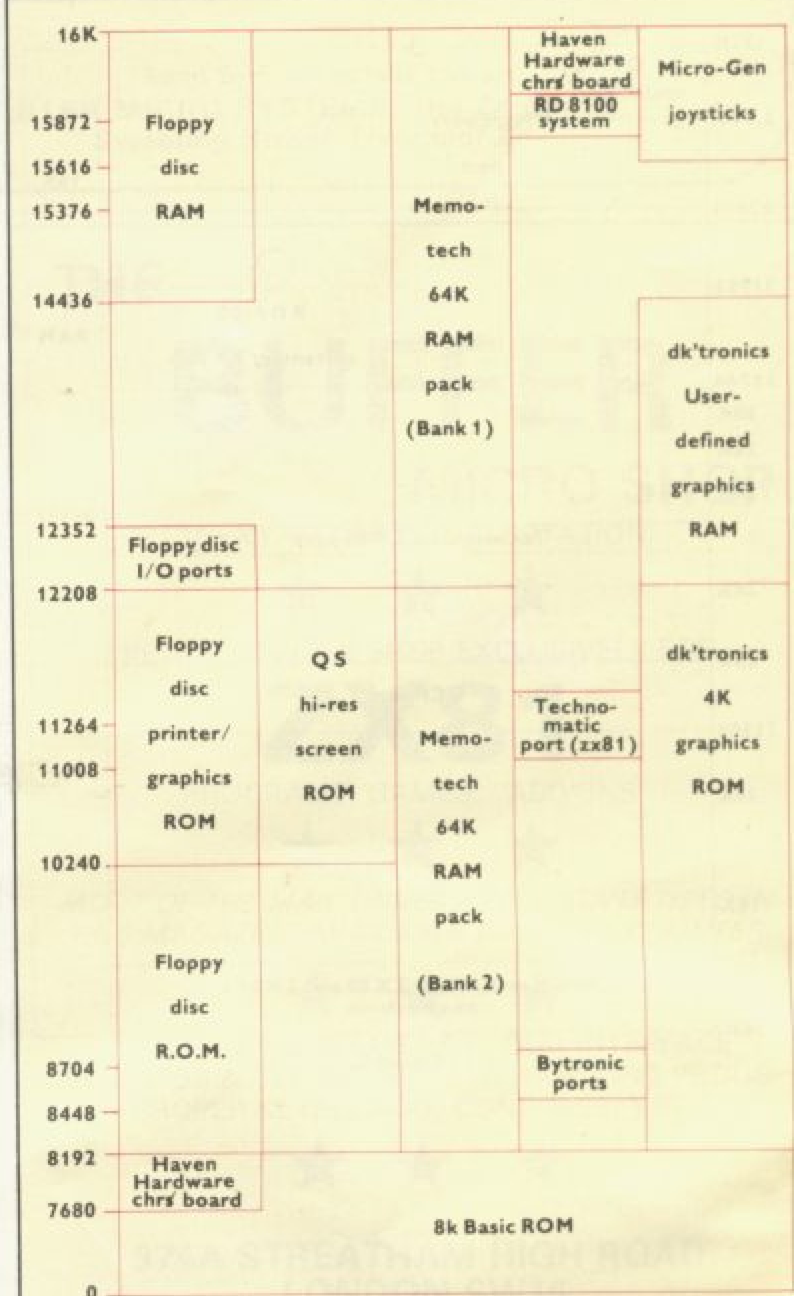
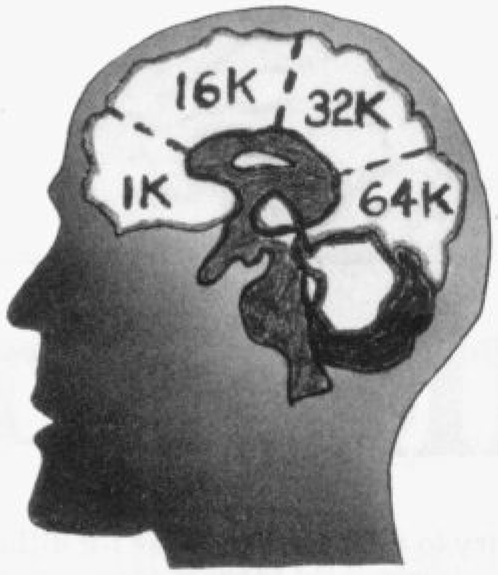


Figure 2.





(continued from page 23)
find, plus their addresses. They also show, by putting into different columns, the devices which cannot be used together. If I have omitted any devices which fit either the ZX-80 or the ZX-81, would people please send me the name and address of the manufacturer and what it does and how many addresses it covers. That includes all the ports if it contains more than one.

I can be contacted through the national ZX-80 and ZX-81 Users Club at 44, Earls Court Road, London W8 6EJ. It is only a post box, so please do not call expecting to see someone connected with the club.

I have included two RAM expansions as they all have to start at 16K and work their way upwards. That memory must be continuous for basic, as the program would crash if it tried to store memory in a RAM location which was not there.

This is the first attempt of which I am aware to try to catalogue all the devices the ZX-80 and ZX-81 can use, but do not write to me for names of the manufactures of these items. The only one lacking the manufacturers name is the floppy disk system which is manufactured by Macronics. For more details on these devices, contact the manufacturer.

Memory Map 16K-32K

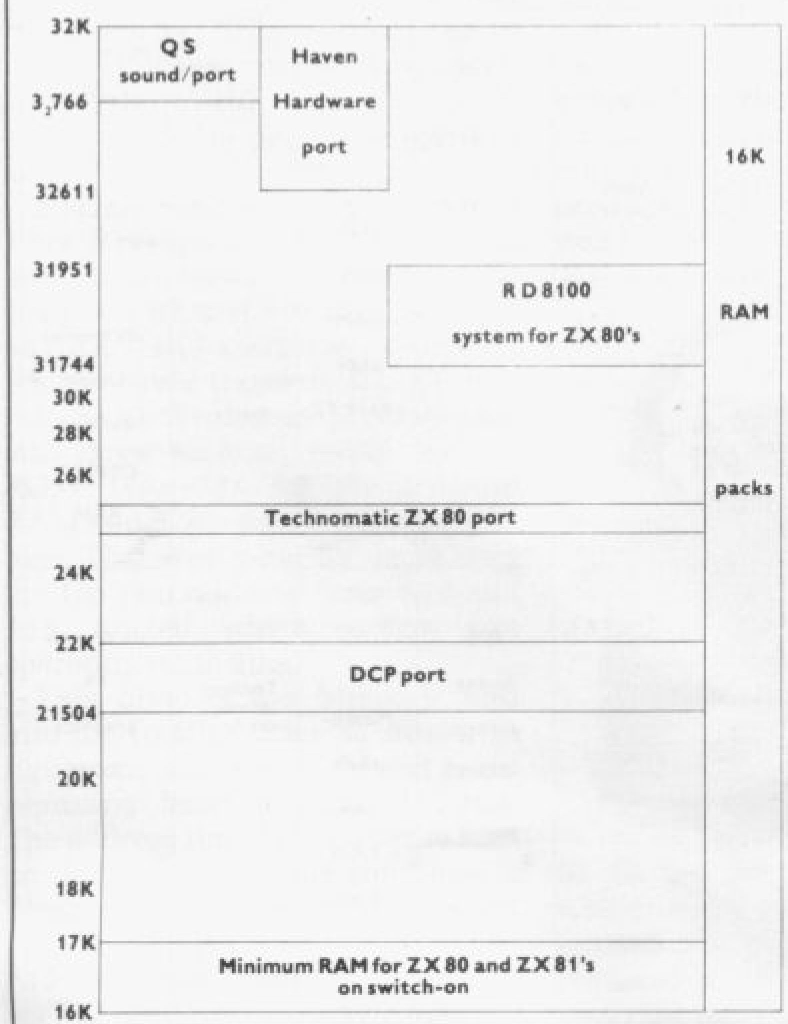


Figure 3.

Memory Map 32K-64K

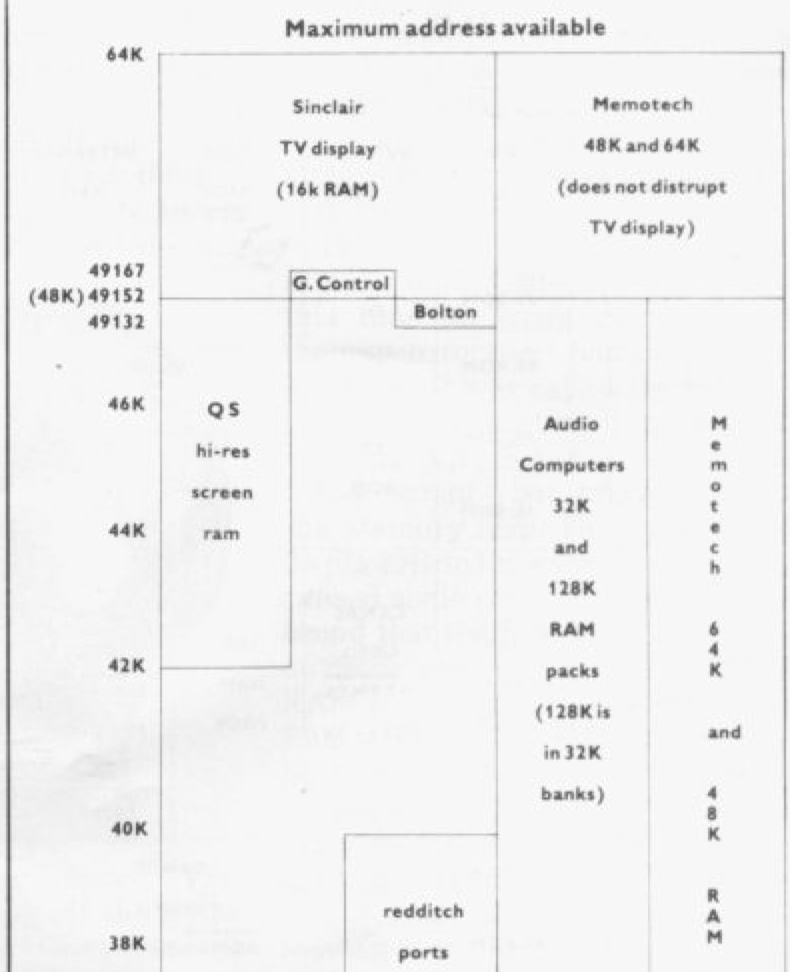


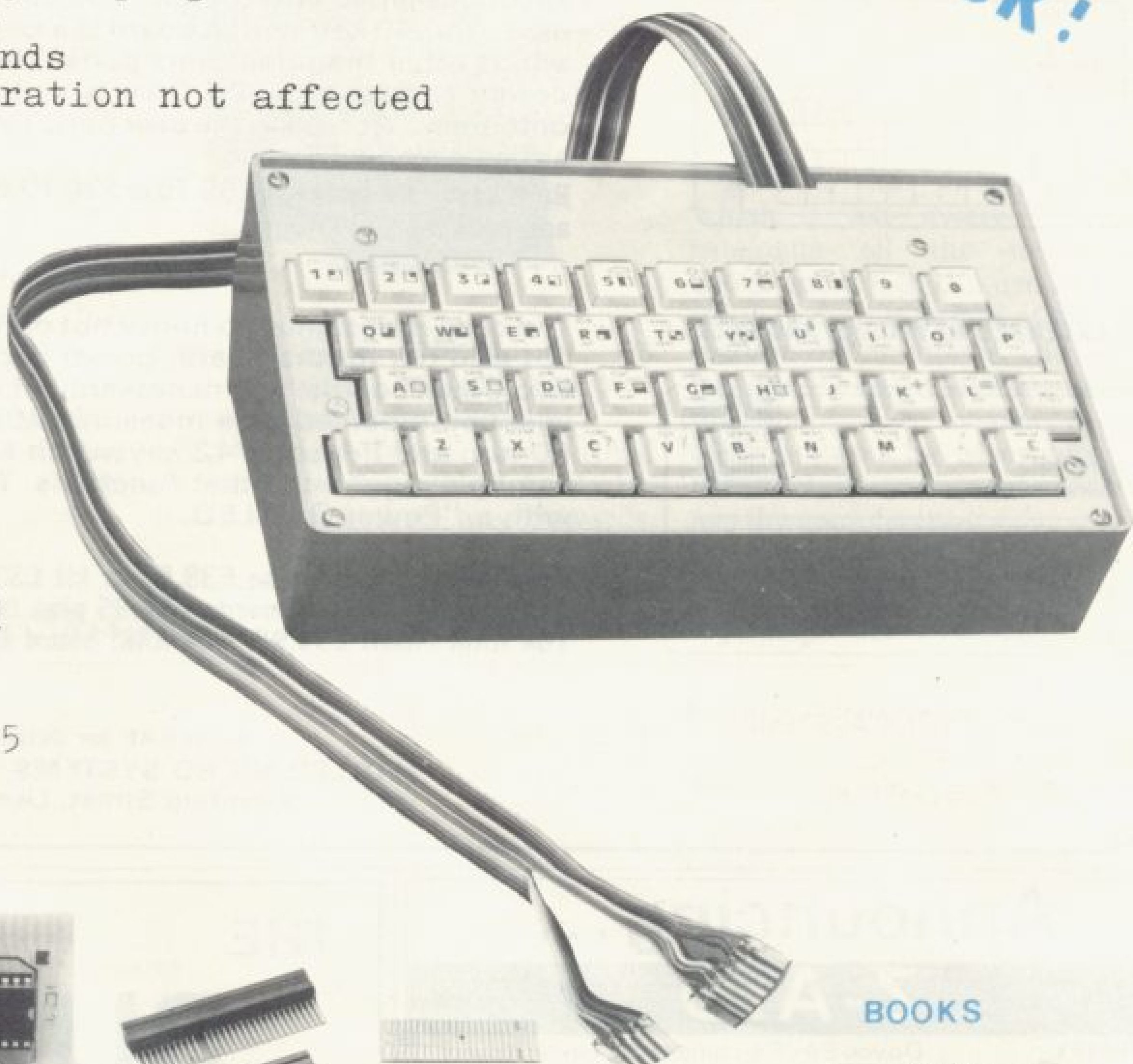
Figure 4.

KEYBOARD £25·70

EX STOCK!

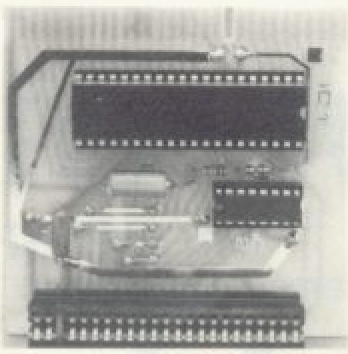
No soldering - just plug in
Proper switches
Two colour legends
RAM/PRINTER operation not affected

KIT £20·50
CASE 10·30
EXTRA KEYS
48 P



MUSIC BOARD

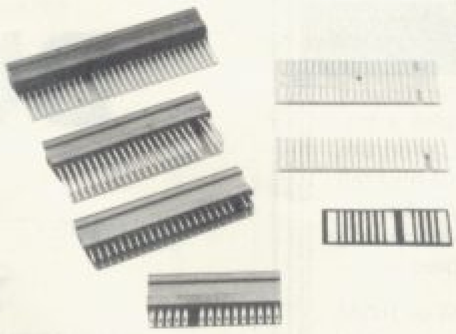
3 channels
Kit £16.95
Built £18.95



IN OUT PORT

24 Lines(in or out)
Controlled by (BASIC)

Built £16.95
Kit £18.95



CONNECTORS

23 Way female	£2.95
23 Way male	1.30
30 way ribbon	1.40

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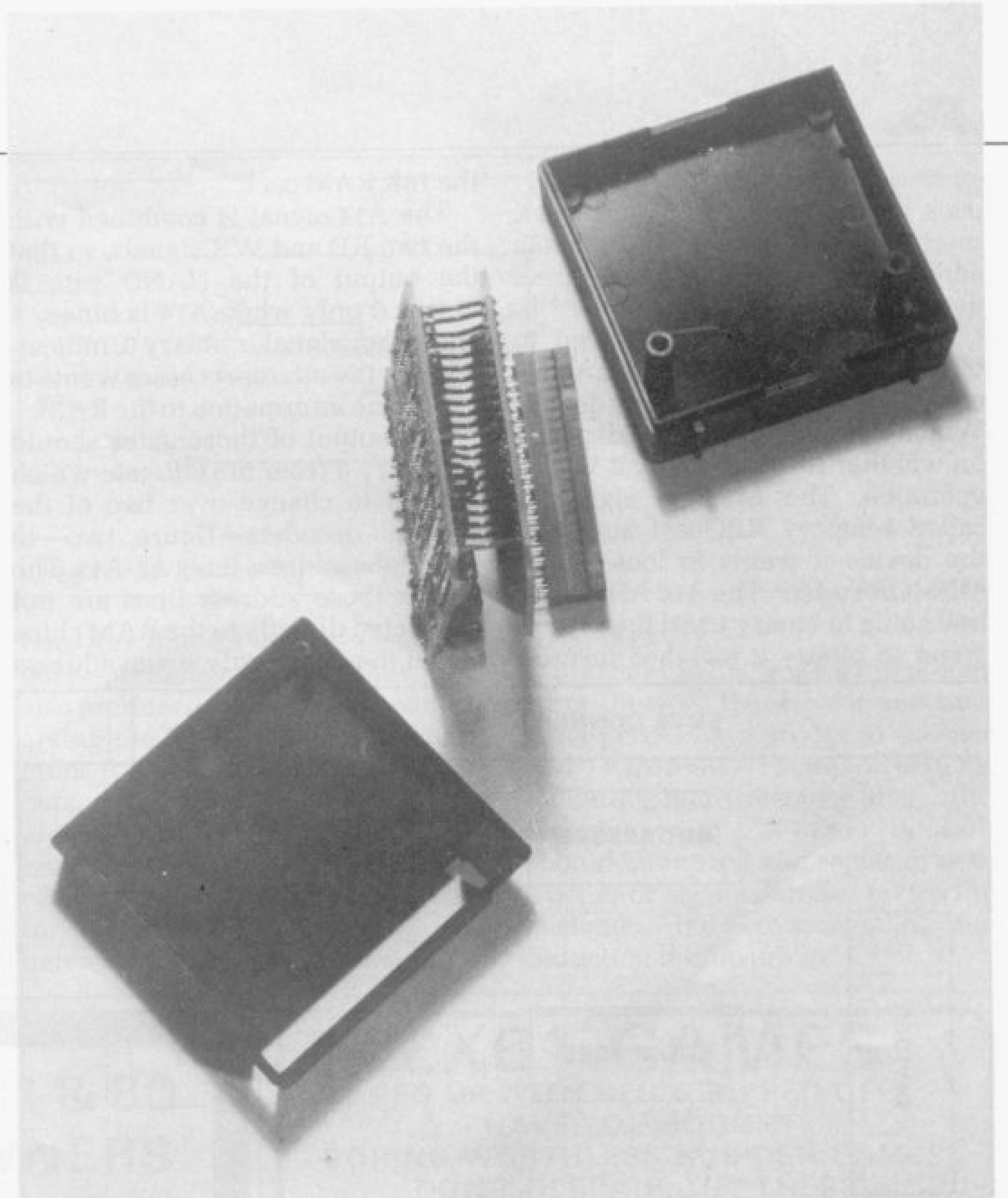
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Programming for real applications	6.95
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Access



Sinclair's star add-on taken to pieces

Adding the 16K RAM to your basic kit certainly makes the ZX-81 even more interesting. Here Stephen Adams dissects the kit and finds it now over-priced.

THE SINCLAIR 16K RAM pack arrived in January, 1981 for the ZX-80. At the time the design was well in advance of any other. Some 16K RAM boards cost more than £150 and the minimum size of the board was 8in. square.

Sinclair reduced the number of chips required and reduced the size dramatically to only 3in. by 3in. by 2in. There were numerous initial problems with the design and there are still difficulties which cannot be solved because they are built into the system.

One of the problems was the number of failures due to whiteouts, as they have been described. That is mainly because of faulty RAM chips which are not checked during manufacture. Tighter checks initiated by Sinclair produced improvements but only after public pressure and the major weakness of the RAM pack is its edge connector. It can also be caused by mains fluctuations.

The edge connector fits on to the ZX-80 or ZX-81 printed circuit board direct and that is smaller than the RAM packs edge connector expects. It also consists of shiny, solder-covered copper tracks and they become very dirty. The only cure is to clean them with methylated spirit and to prevent the contacts becoming dirty, by coating the printed circuit board with petroleum jelly. Because the edge of the board is smaller than the edge connector, the RAM packs tend to wobble and that is not helped by the fact that the keyboard tends to lift the RAM pack off its surface.

Originally, Sinclair had intended that the 16K RAM was the only extension which would be produced for Sinclair machines and so cut off anything connecting to the computer when the RAM pack was connected. So you need to use a motherboard if you want to use the RAM pack with other equipment.

The only other problem was the way that Sinclair had reduced the number of components for the RAM pack. That was done by simplifying the ADDRESS which turned on the 16K RAM pack.

The ZX-80, for which the RAM pack was designed, originally used only two lines to decode what devices to turn on within the memory map. Three devices are used in the ZX-80 memory map—the RAM, both 1K and 16K, the ROM and the screen display.

The maximum number of devices which can be turned on from two binary ADDRESS lines is four. Sinclair uses the line A14 to turn on both the RAM and the ROM. The RAM is turned on to it by using binary 1 and the ROM when it is binary 0. The screen display is turned on when A15 is binary 0. When the count is 4 or in binary 11, both the RAM and the screen display are on and that is the only time the display is sent to the TV. The RAM therefore exists at two places on the memory map, 16K-32K (A15 = 0) and 48K-64K (A15 = 1). As the 16K RAM

(continued on page 28)



(continued from page 27)
pack had to take over from the 1K internal RAM, it had to use the same addressing system. The address decoding is shown in figure one.

The RD and WR signals go to binary 0 when the Z-80A microprocessor wants to talk to any device. Which one goes to binary 0, depends on whether it is a ReaD or a WRite operation. The MREQn signal is called Memory REQuest and tells the device it wants to look at the MEMORY MAP. The A14 ADDRESS line going to binary 1 and the MREQ going to binary 0 together turn on the 16K RAM pack.

The A14 signal is combined with the two RD and WR signals, so that the output of the NAND gate is binary 0 only when A14 is binary 1 and either signal is binary 0, indicating that the microprocessor wants to pass some information to the RAM.

The output of those gates should be binary 0 from the OR gate which is used to change over two of the address decoders—figure two—to look at the address lines A7-A13. The reason those address lines are not connected directly to the RAM chips is that they have only seven address pins. The RAM must therefore be addressed in two stages, ROM address and COLOMN address. The address lines A13-A7 act as the ROW address and A6-A0 act as the COLOMN address.

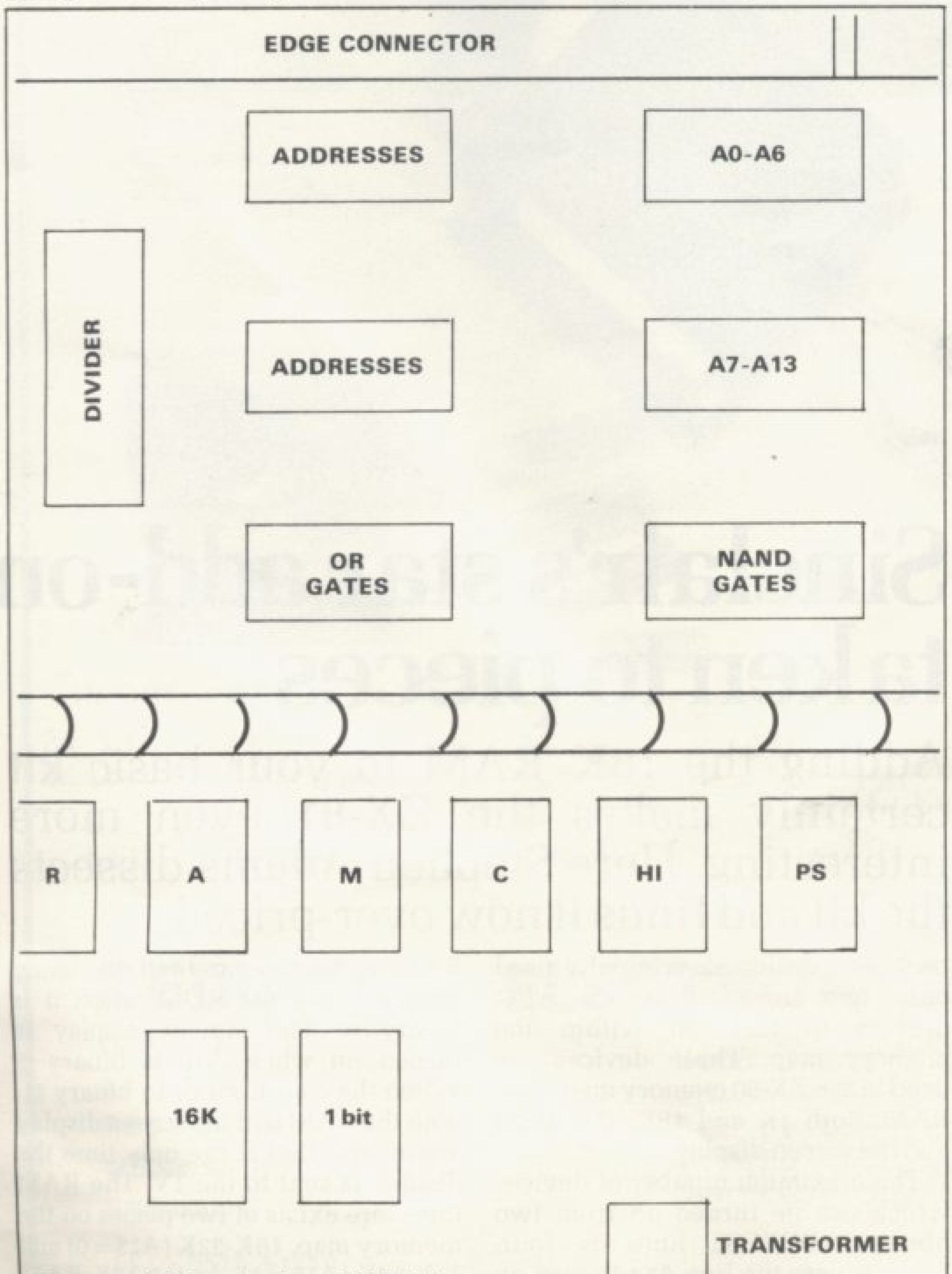


Figure 1. Addressing the 16K RAM.

The changeover from ROW address to COLOMN address is controlled by the divider chip. That chip also provides the REFRESH address used by dynamic memories, such as the 4116 (16 × 1 bit) chips used in the RAM. That is because although the REFRESH signal is given out by the processor at the correct time, the address given by the Z-80A processor is incorrect, because the refresh register (R) within the processor is used by Sinclair for another purpose—putting out the character set.

The dynamic memories must be refreshed within a certain time or the data will be lost. The refreshing is done by the chip—by reading-out the bit and then writing it back again—but it needs to know what data location within the RAM to next.

The data lines from the chips are not buffered, so they can be placed only a short distance from the computer without causing problems. The data lines within the computer are also protected by resistors, so any extra loading on to the expansion port to use other equipment must be buffered.

The 4116 RAM chips used in the design do not require only a +5V supply; they also need +12V and –5V. The +12V supply can be replaced with the +9V and it just works but the –5V supply has to generate in a different way.

A transformer is used—figure two—along with a transistor to form an oscillator driven from the +9V supply. The transformer then steps-down the voltage created by the oscillator to 5V. As both sides of the transformer are isolated from each other, the voltage can be rectified into a DC voltage, with the positive terminal connected to the 0V line. That is then passed to the RAM chips alone, as the current generated is very small. The transformer also
(continued on page 29)





(continued from page 28)

creates the characteristic humming or buzz of the 16K RAM pack.

Since Sinclair produced the RAM pack, memory RAM chip prices have fallen dramatically and the price of a 416 chip on the retail market is somewhere in the region of 45 pence. The design in early 1981 was inexpensive, very efficient and small in size, but it has not been improved to date, neither has the price fallen in response to the fall in the price of chips.

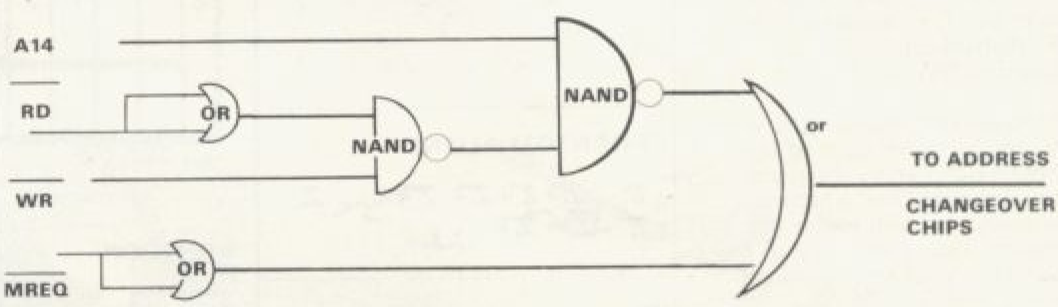


Figure 2. Layout of the 16K RAM pack.

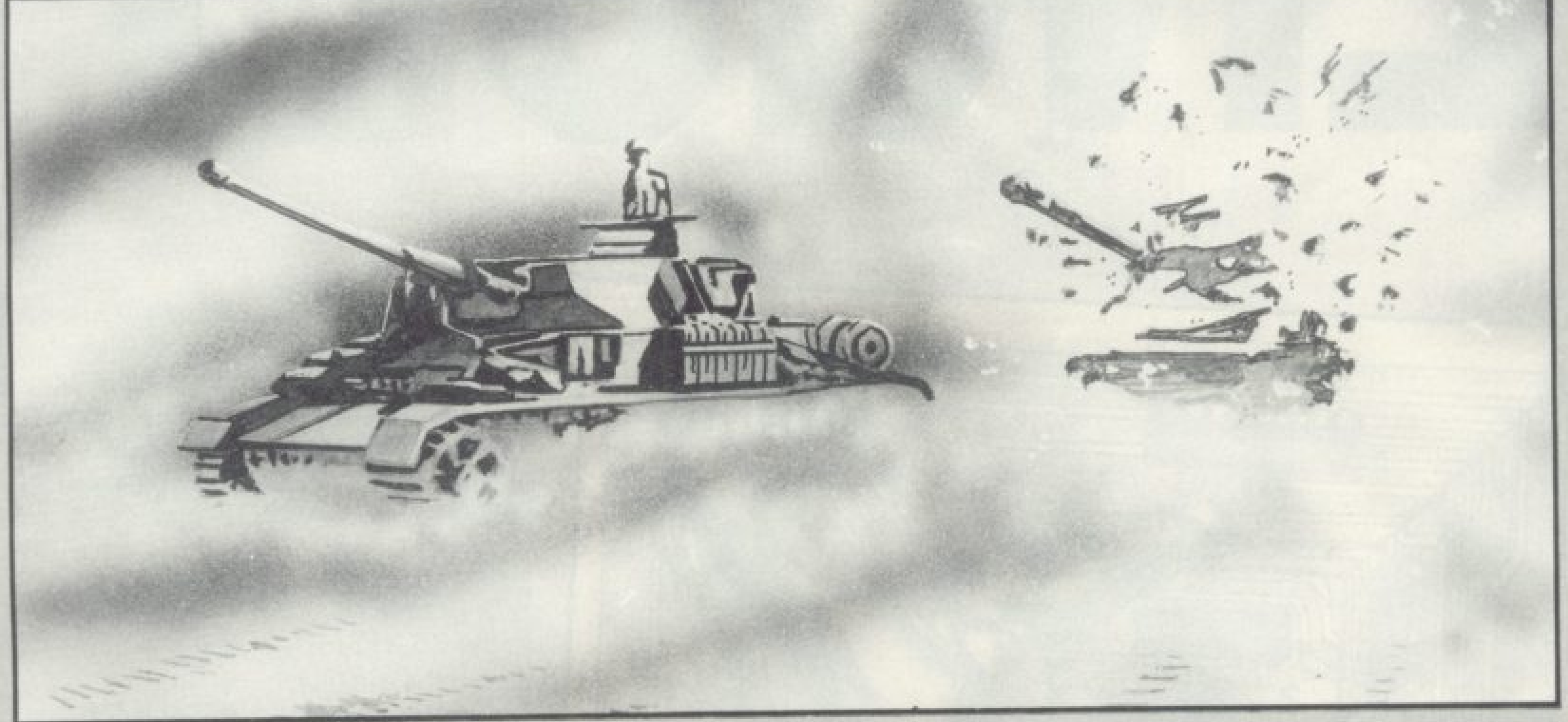
The 16K RAM pack therefore is looking over-priced to people who can now obtain a better version—no humming and better reliability—for about £35.

Manufacturers have now had sufficient time to produce a design which includes buffering—so that more boards can be driven direct—and still turns off the internal 1K RAM by holding the RAM CS line—on line 2A of the expansion port—permanently off. They have also produced RAM packs capable of giving the Sinclair Basic 48K maximum RAM to use for program and data. That applies only at the moment to ZX-81. A 64K RAM pack has just reached the market with 48K of Basic memory and 8K of memory for machine code, swapping data between programs. The cost of the RAM pack is £79.

Sinclair has made plenty of money from the 16K RAM pack and now other people have produced cheaper and apparently better versions, including more memory than 16K, for owners of ZX-81s. I think it should be retired and replaced with a better or cheaper model, giving the customer the advantage of the reduction in chip prices.

8 PAGES OF PROGRAMS

for both the ZX-80 and the ZX-81



MINEFIELD

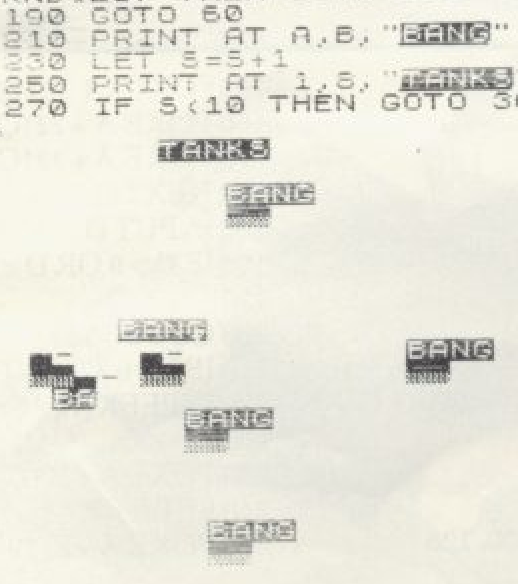
YOU ARE in command of a squadron of tanks in *Minefield*, the 1K ZX-81 game. Before you lies an enemy minefield through which you must pass. How many of your tanks will be lost finding a safe route?

When you run the program, the computer will generate a minefield—a different one each time you play. Drive your first tank across the screen, using the forward, up and down keys. Be careful not to use other keys.

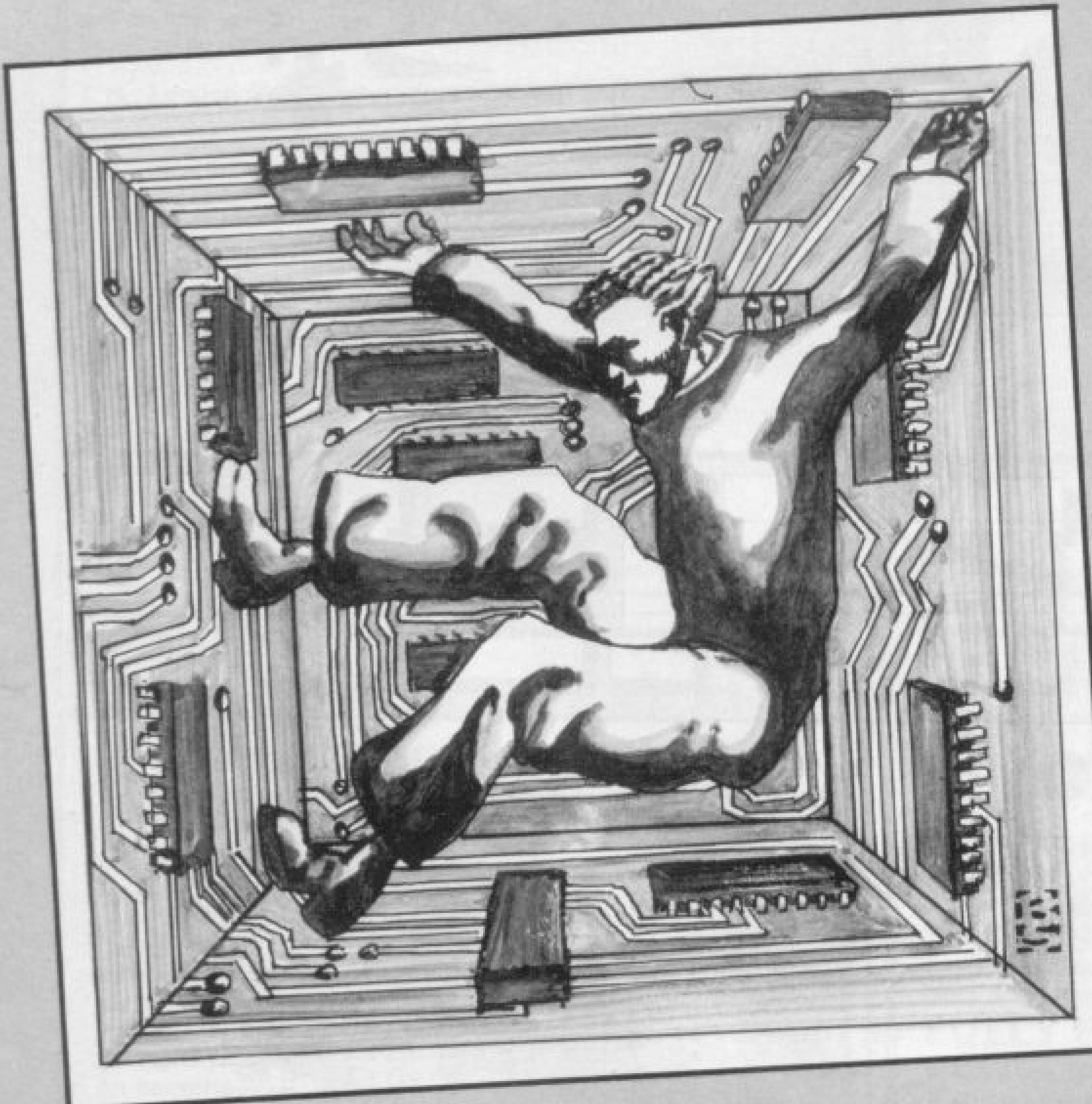
If you hit a mine the tank blows up and you must try again with the next tank. They are multiple mines and will destroy every tank which hits them. Your score is displayed at the top of the screen. If you are successful in finding a way across, the programs stops.

You will find you become proficient at avoiding the littered battlefield as the game progresses. The program was adapted by Tim Hartnell from the original program written by I S Howson.


```
  10 LET S=PI-PI
  15 LET X=8
  20 LET C=X
  30 RAND
  40 LET B=C-C
  45 PRINT AT S-S,S-S;S
  50 LET A=10
  60 PRINT AT A-A/A,B;"     "
  70 PRINT AT A,B;" ▄-"
  80 PRINT AT A+A/A,B;" ▀▀▀"
  90 PRINT AT A+2,B;"     "
 110 IF INKEY$<>"" THEN LET C=CO
DE (INKEY$)-28
 130 IF C=X THEN LET B=B+X/X
 150 IF C<X THEN LET A=A+13-C*2
 170 IF B=INT (RND*30) OR A=INT
(RND*20) THEN GOTO 210
 190 GOTO 60
 210 PRINT AT A,B;"BANG"
 230 LET S=S+1
 250 PRINT AT 1,S;"TANKS"
 270 IF S<10 THEN GOTO 30
```



ENGULF



ENGULF is for the 1K ZX-80, by Graham Charlton of Rise Park, Romford. It sets you against a vengeful computer. After you press RUN, a large black square will appear. That is the playing area. You have five controls:

7—UP
6—DOWN
5—LEFT
8—RIGHT
9—SCORE.

After pressing 5, 6, 7 or 8, followed be NEWLINE, you will appear as an addition sign (+) with an inverse space, CHR$(128), next to it. Everytime you move, the computer will place a black square next to your piece. The idea is to avoid being trapped, or engulfed, for as long as possible. Once you have been caught, press 9 to see your final score.

Charlton's best score is 154. You can make the game slightly easier by deleting line 280, which prevents the computer placing a black square where a black square already exists. The game shows PEEKing and POKEing to the display file in action. The crucial line is 100, which finds the beginning of the display file.

```
10 LET A=0
20 LET E=236
30 FOR C=1 TO 21
40 FOR G=1 TO 21
50 PRINT "*";
60 NEXT G
70 PRINT
80 NEXT C
90 LET G=0
100 LET A=1+PEEK (16396)+PEEK (16397)*256
110 FOR C=0 TO 20
120 POKE A+C, 128
130 POKE A+C+22*20, 128
140 NEXT C
150 FOR C=1 TO 21
160 POKE A+22*C, 128
170 POKE A+22*C+20, 128
180 NEXT C
190 INPUT D
195 IF D>9 OR D<5 THEN GO TO 190
200 GOSUB 320
210 IF D=9 THEN GOTO 380
220 IF PEEK (A+F)=128 THEN GOTO 190
230 POKE A+E, 0
240 LET E=F
250 POKE A+E, 19
260 LET D=RND(4)+4
270 GOSUB 320
280 IF PEEK (A+F)=128 THEN GOTO 260
290 POKE A+F, 128
300 LET G=G+1
310 GOTO 190
320 LET F=E
330 IF D=5 THEN LET F=F-1
340 IF D=8 THEN LET F=F+1
350 IF D=6 THEN LET F=F+22
360 IF D=7 THEN LET F=F-22
370 RETURN
360 PRINT "YOU SCORED*"; G
```

GALAXY PATROL

GALAXY PATROL, written by R Stubbs of Shearing Hill, Nottinghamshire, places you in command of a galactic patrol ship which bears an uncanny resemblance to the letter V.

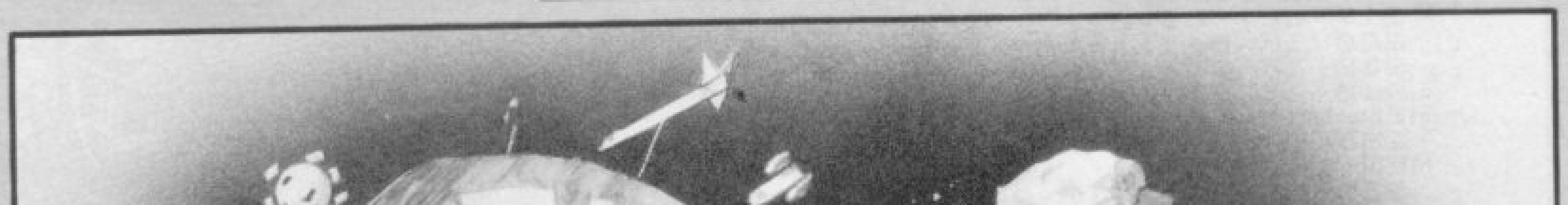
Your V wing fighter starts with 50 gallons of fuel which decreases slowly. The amount of fuel remaining is in the top right of the screen; in the screen printout the fuel figure is 33.

You re-fuel your fighter by hitting any of the random fuel dumps—inverse spaces. Each time you run through a fuel dump, you receive 25 gallons. You control your craft by touching the M key. Holding-down the M moves you to the right; leaving the keyboard untouched allows your craft to drift sideways.

The game ends and your score is displayed either when you run out of fuel or hit an asteroid (asterisk).

Line 130 looks at the PRINT position—set by the last PRINT AT in line 110—and if it finds a 23 (asterisk) stops the game there, printing the score (S) and using an unassigned variable (D) to halt the game. If it finds a 128, the computer knows you are running into a fuel dump, so the fuel is incremented by 25—LET F=F+25. Line 145 stops the game if you are out of fuel, i.e., if F equals zero.


```
   5 LET F=50
  10 LET S=F-F
  20 LET A=5
  30 LET B=13
  40 LET C=10
  50 PRINT AT C,RND*30;"*"
  55 LET R=INT (RND*10)+1
  57 IF R=9 THEN PRINT AT 8,RND*
30;"█"
  70 LET S=S+1
  75 LET F=F-1
  80 SCROLL
  90 IF B>2 THEN LET B=B-1
 100 IF INKEY$="M" AND B<28 THEN
 LET B=B+2
 110 PRINT AT A,B;"V";TAB 29;F;A
T 1,B;
 130 LET M=PEEK (PEEK 16398+256*
PEEK 16399)
 135 IF M=23 THEN PRINT S;D
 140 IF M=128 THEN LET F=F+25
 145 IF F=0 THEN PRINT S;D
 150 GOTO 50
                *     V          33
                             *
         *
                          *█
                   █ *
     *
           *
    *
                   *
         *
```

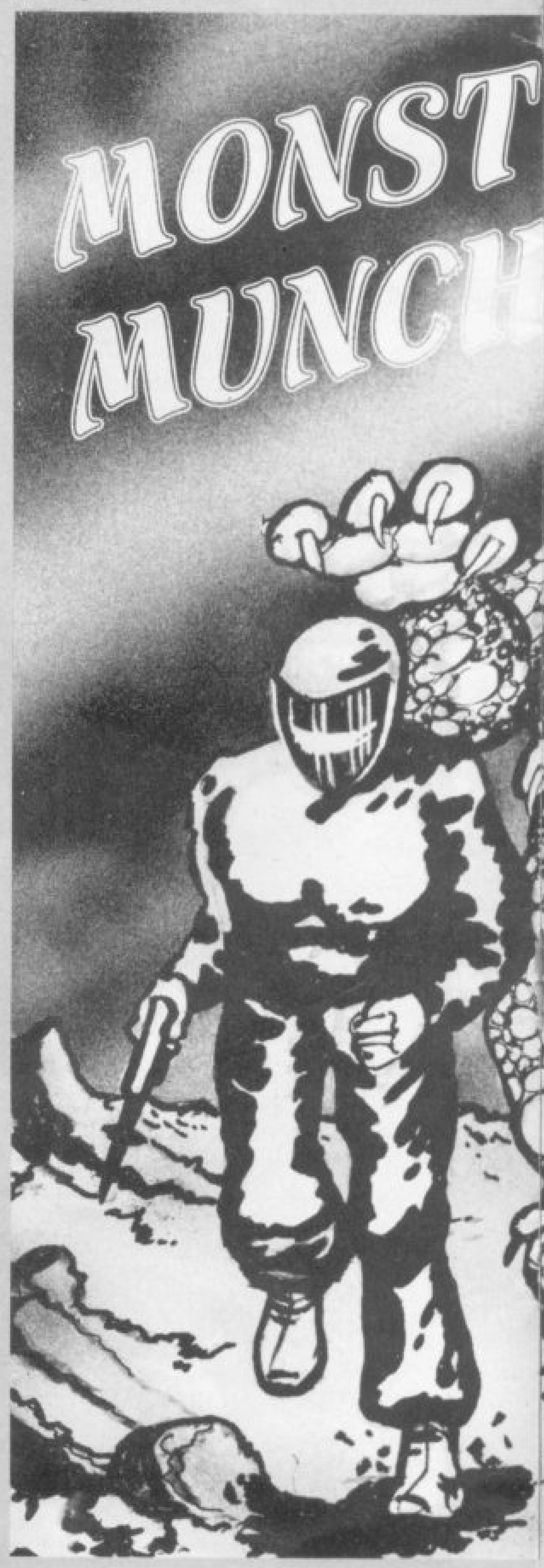


THERE ARE two versions of *Monster Munch*, written by Tim Hartnell, in which you—the inverse H—have to escape the monster—the inverse M—on a 10 × 10 grid of full stops.

Beware, however, because your task is hopeless. No matter what you do, you will be unable to evade it for ever and will be utterly and completely munched.

```
  10 DIM A(100)
  20 LET Z=0
  30 LET M=RND
  40 LET H=RND
  50 LET X=INT (RND*2)+1
  60 LET Y=INT (RND*2)
  70 LET P=INT (RND*2+7)
  80 LET Q=INT (RND*2+8)
  85 LET A(X+10*Y)=M
  90 LET A(P+10*Q)=H
 100 REM PRINT OUT
 110 PRINT AT 5,0;
 120 FOR D=1 TO 100
 130 IF A(D)=0 THEN PRINT ".";
 140 IF A(D)=M THEN PRINT "M";
 150 IF A(D)=H THEN PRINT "H";
 160 IF 10*INT (D/10)=D THEN PRI
NT
 170 NEXT D
 175 IF Z=1 THEN GOTO 1000
 180 LET A(Γ+10*Q)=0
 190 LET A(X+10*Y)=0
 200 REM PLAYER MOVE
 210 PRINT "ENTER YOUR MOVE N,S,
E,W,)","(NE,NW,SE,SW)"
 215 INPUT B$
 217 LET B$=B$+" "
 220 IF B$(1)="N" THEN LET Q=Q-1
 230 IF B$(1)="S" THEN LET Q=Q+1
 240 IF B$(1)="E" OR B$(2)="E" T
HEN LET P=P+1
 250 IF B$(1)="W" OR B$(2)="W" T
HEN LET P=P-1
 300 LET A(P+10*Q)=H
 400 REM COMPUTER RESPONDS
 410 IF P>X AND X<10 THEN LET X=
X+1
 420 IF P<X AND X>1 THEN LET X=X
-1
 430 IF Q>Y AND Y<10 THEN LET Y=
Y+1
 440 IF Q<Y AND Y>1 THEN LET Y=Y
-1
 500 LET A(X+10*Y)=M
 600 REM MUNCH...
 610 IF X+10*Y=P+10*Q THEN LET Z
=1
 900 GOTO 100
2000 PRINT AT 10+RND*10,10+RND*1
0;"■■HA, GOTCHA HUMAN■■"
2010 GOTO 2000
```

```
.M........
..........
..........
..........
..........
..........
..........
..........
..........
......H...
ENTER YOUR MOVE N,S,E,W,)
(NE,NW,SE,SW)
```

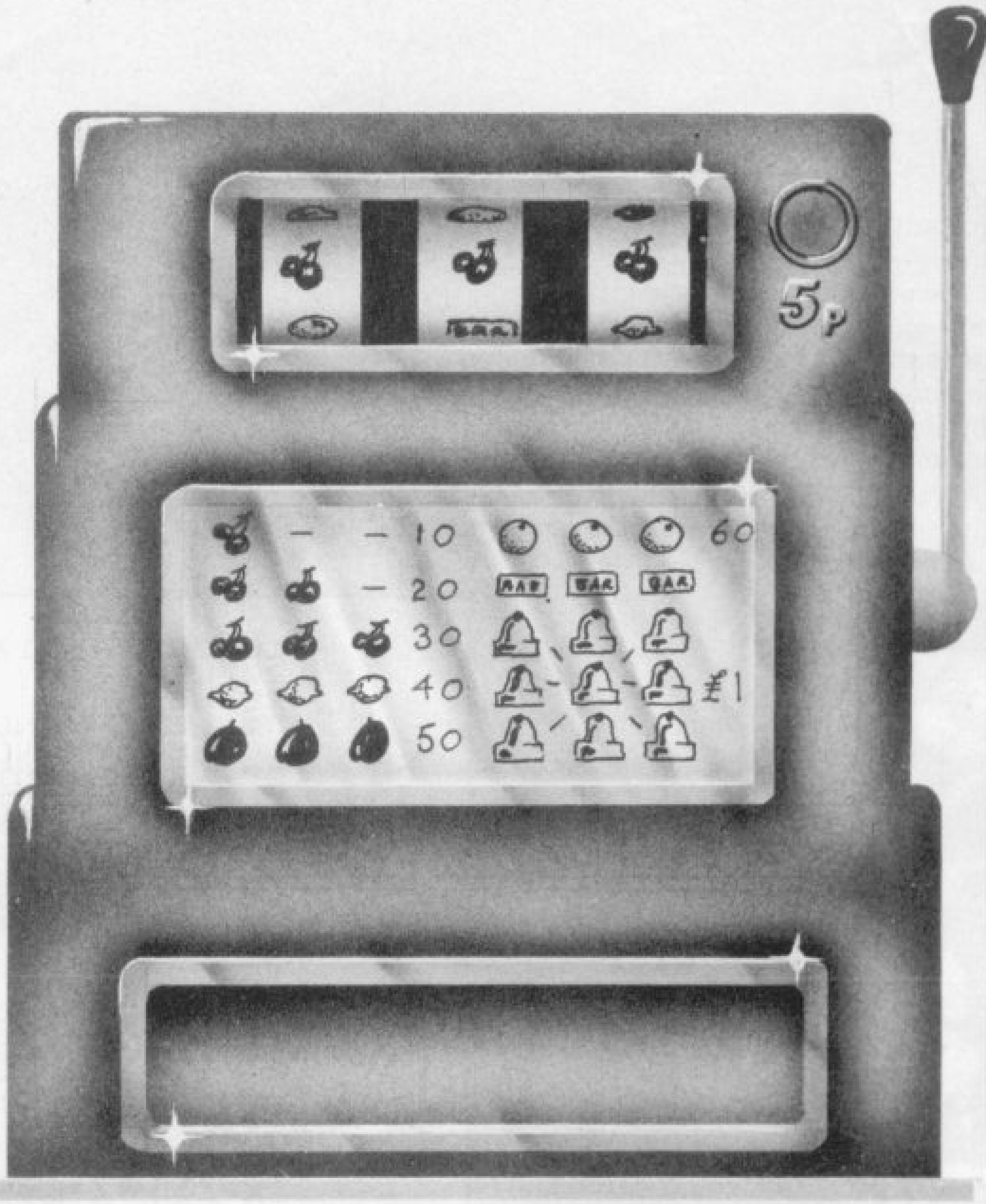


You enter your direction of move—N, S, W or whatever, as shown in line 210. The second version of the program is a little more elaborate in its display and has a scoring mechanism. You can convert the listing easily for game one into game two. You will need more than 1K on your ZX-81 for the game.




```
  10 DIM A(110)
  20 LET Z=0
  25 LET S=0
  30 LET M=RND
  40 LET H=RND
  50 LET X=INT (RND*2)+1
  60 LET Y=INT (RND*5)
  70 LET P=INT (RND*2+7)
  80 LET Q=INT (RND*2+8)
  85 LET A(X+10*Y)=M
  90 LET A(P+10*Q)=H
 100 REM PRINT OUT
 110 PRINT AT 5,0;"SCORE ";S
 115 PRINT
 120 FOR D=1 TO 100
 130 IF A(D)=0 THEN PRINT ".";
 140 IF A(D)=M THEN PRINT "■";
 150 IF A(D)=H THEN PRINT "■";
 160 IF 10*INT (D/10)=D THEN PRI
NT
 170 NEXT D
 175 IF Z=1 THEN GOTO 1000
 180 LET A(P+10*Q)=0
 190 LET A(X+10*Y)=0
 200 REM PLAYER MOVE
 210 PRINT "ENTER YOUR MOVE N,S,
E,W,)","(NE,NW,SE,SW)"
 215 INPUT B$
 216 IF B$(1)="S" AND Q>8 OR B$(
1)="N" AND Q<1 OR B$(1)="E" AND
P>9 OR B$(1)="W" AND P<2 THEN GO
TO 215
 217 LET B$=B$+" "
 220 IF B$(1)="N" THEN LET Q=Q-1
 230 IF B$(1)="S" THEN LET Q=Q+1
 240 IF B$(1)="E" OR B$(2)="E" T
HEN LET P=P+1
 250 IF B$(1)="W" OR B$(2)="W" T
HEN LET P=P-1
 260 LET S=S+1
 300 LET A(P+10*Q)=H
 400 REM COMPUTER RESPONDS
 410 IF P>X AND X<10 THEN LET X=
X+1
 420 IF P<X AND X>1 THEN LET X=X
-1
 425 PRINT AT 0,10;"■";AT 0,10;"
*";AT 0,10;" "
 430 IF Q>Y AND Y<10 THEN LET Y=
Y+1
 435 PRINT AT 0,10;"■";AT 0,10;"
*";AT 0,10;" "
 440 IF Q<Y AND Y>0 THEN LET Y=Y
-1
 450 PRINT AT 0,10;"■";AT 0,10;"
*";AT 0,10;" "
 500 LET A(X+10*Y)=M
 600 REM MUNCH...
 610 IF X+10*Y=P+10*Q THEN LET Z
=1
 900 GOTO 100
2000 PRINT AT 10+RND*10,10+RND*1
0;"■■HA, GOTCHA HUMAN■■"
2010 GOTO 2000
```

JACKPOT



DANIEL KING, of Headington, Oxford, suggests that the 1K ZX-81 *Jackpot* program could be used for school fund-raising days, charging fivepence for people to press NEWLINE for a spin on the ZX-81 fruit machine. They are paid eightpence for two identical symbols and 15 pence for three. That, King assures us, means a profit of 25p on 20 games. Simply RUN the program, then press R to roll or return.

If you have more than 1K, enter a routine to total your money—wins and costs—automatically. A HOLD would also enhance the game.

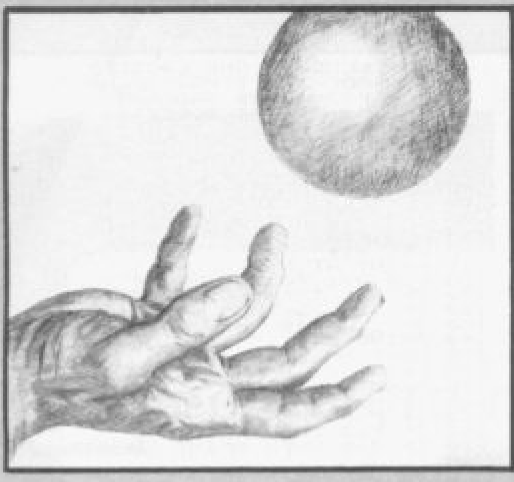
Running the program gives a very effective impression of reels of symbols spinning, before settling on one in each window.

```
JACKPOT

PUSH R FOR ROLL. COST...5P

TWO PAY 8P...THREE PAY 15P
```

```
   2 PRINT AT 3,12;"JACKPOT";AT
5,12;"▒▒▒▒▒▒▒▒▒";AT 6,12;"▒ ▒ ▒ ▒"
;AT 7,12;"▒▒▒▒▒▒▒▒▒"
   3 PRINT AT 9,0;"PUSH R FOR RO
LL. COST...5P";AT 11,0;"TWO PAY
8P...THREE PAY 15P"
   5 IF INKEY$<>"R" THEN GOTO 4
   6 LET B$="OX* ▄▒▀"
   7 DIM A$(3)
   8 FOR F=1 TO 3
  10 LET J=INT (RND*7)+1
  20 LET A$(F)=B$(J)
  50 NEXT F
  80 FOR F=1 TO 3
  82 FOR J=1 TO 7
  83 PRINT AT 6,11+2*F;B$(J)
  84 NEXT J
  85 IF RND<.6 THEN GOTO 82
  86 PRINT AT 6,11+2*F;A$(F)
  90 NEXT F
 100 IF INKEY$<>"R" THEN GOTO 10
0
 110 RUN
```



CATCH

ANDREW LOVERING has spent many hours with his 1K ZX-81 in Maidenhead in producing the fine game of *Catch*. You will see, when you press RUN, an open box near the bottom of the screen. Pressing 8 moves you to the right, 5 moves you to the left. You have to try to catch a rapidly-descending ball dropped from a random position at the top of the screen.

To confuse you, and to introduce a little luck into the game, a lid appears at random places above the box. If the ball hits the bottom, or the lid, the game ends and your score is printed.

```
 10 LET D=0
 20 LET A=14
 30 LET C=INT (RND*30)+1
 40 LET B=0
 50 LET B=B+1
 60 PRINT AT B,C;"O"
 70 LET E=INT (RND*30)
 80 PRINT AT 19,E;" ▄▄ "
 90 PRINT AT 20,A;" █ █ "
100 PRINT AT 21,A;" ███ "
110 IF INKEY$="5" AND A>0 THEN
LET A=A-1
120 IF INKEY$="8" AND A<29 THEN
LET A=A+1
130 IF B=18 AND C=E+1 THEN GOTO
220
140 IF B=20 AND C=A+1 THEN GOTO
180
150 IF B=21 THEN GOTO 220
160 CLS
170 GOTO 50
180 LET D=D+1
190 PRINT AT 0,0;"SCORE ";D
200 FOR J=1 TO 50
205 NEXT J
210 GOTO 20
220 PRINT AT 0,0;"SCORE ";D
230 PAUSE 4E4
240 RUN
```

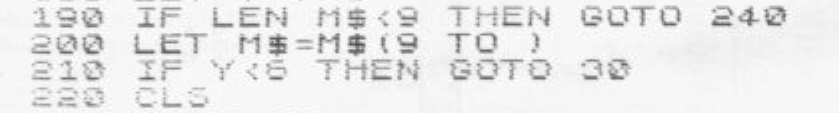

LARGE LETTERS

THIRTEEN-YEAR-OLD Christopher Lowe, who lives in Edinburgh, says of his program, *Large Letters*, which fits a 1K ZX-81, that it will allow you to obtain an enlarged version of any character, ordinary, inverse—as in the sample printout—or graphic.

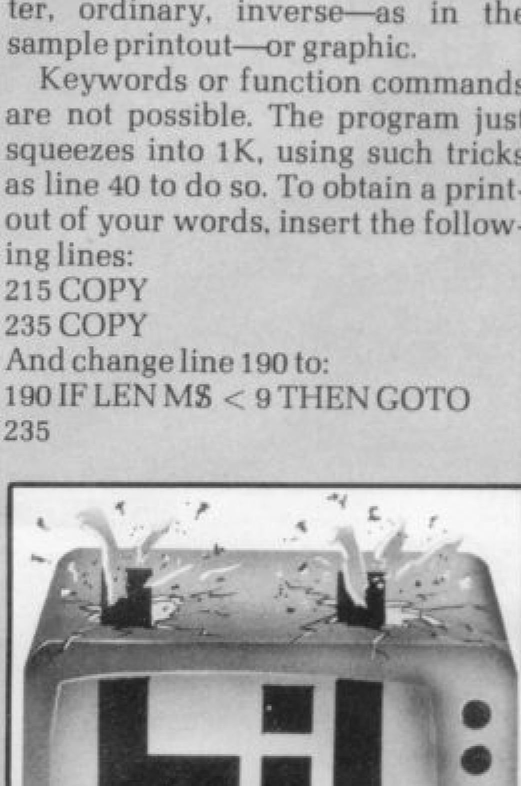
Keywords or function commands are not possible. The program just squeezes into 1K, using such tricks as line 40 to do so. To obtain a printout of your words, insert the following lines:

215 COPY
235 COPY
And change line 190 to:
190 IF LEN M$ < 9 THEN GOTO 235

```
 10 INPUT M$
 20 LET Y=VAL "43"
 30 FOR C=1 TO 8
 40 LET L=VAL "0"
 50 IF CODE M$(C)>100 THEN LET
L=VAL "128"
 60 FOR N=0 TO 7
 70 LET Z=PEEK (7680+N+8*(CODE
M$(C)-L))
 80 FOR X=1 TO 8
 90 LET Z=VAL "Z/2"
100 IF CODE M$(C)>100 THEN GOTO
130
110 IF Z<>INT Z THEN PLOT 8*C-X
,Y-N
120 GOTO 140
130 IF Z=INT Z THEN PLOT 8*C-X,
Y-N
140 LET Z=INT Z
150 NEXT X
160 NEXT N
170 NEXT C
180 LET Y=Y-8
190 IF LEN M$<9 THEN GOTO 240
200 LET M$=M$(9 TO )
210 IF Y<6 THEN GOTO 30
220 CLS
230 GOTO 20
```



This program is a development of one which appeared in the October 1981 issue of *Interface*. It is copyright Christopher Lowe, © 1982.

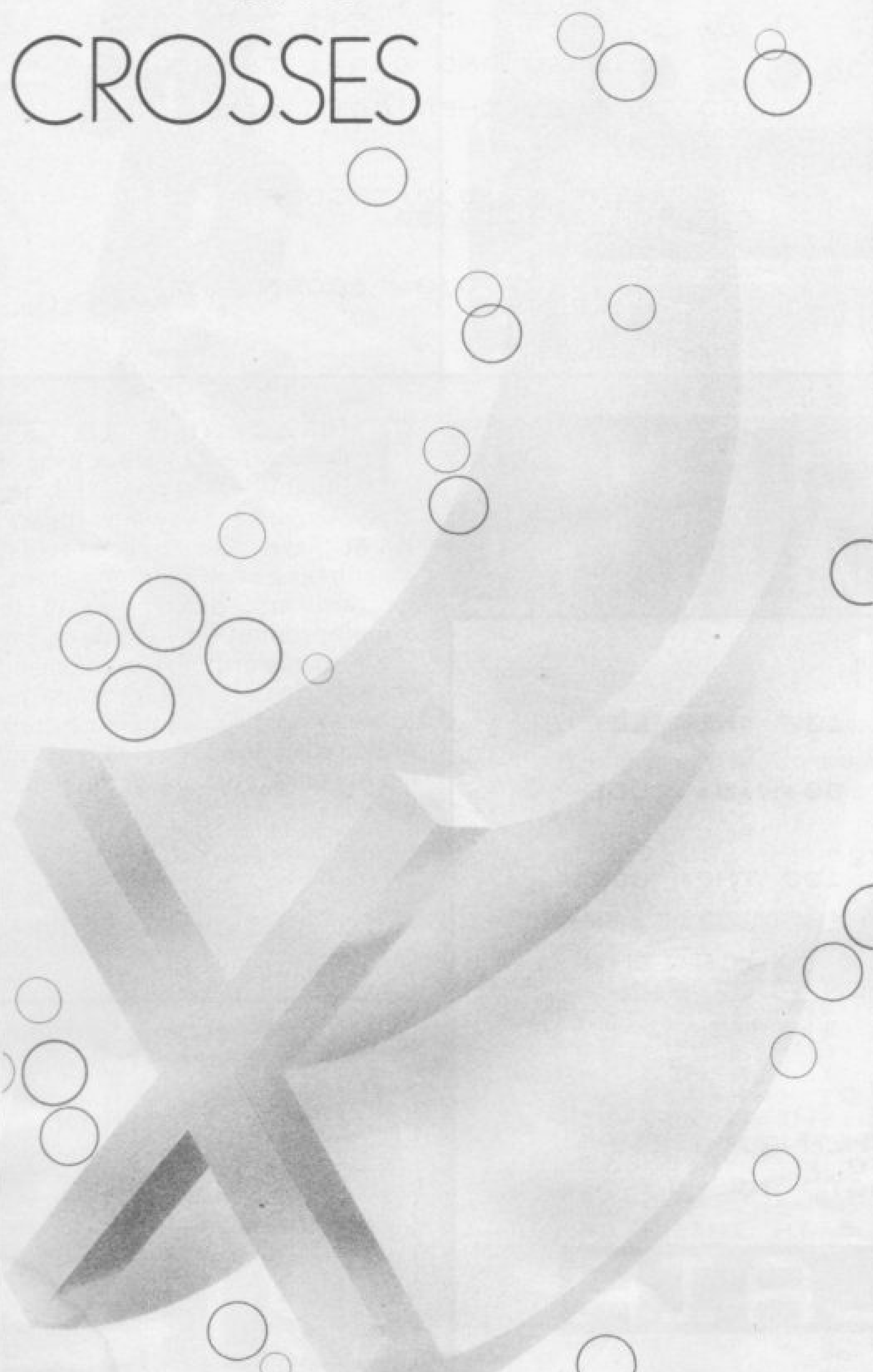


ADAPTED for a ZX-81 with more than 1K from a ZX-80 program written by Stuart Roberts, this *Noughts and Crosses* gives you a chance to win now and then, unlike many computer *Noughts and Crosses* which are unbeatable.

Usually, the best for which you can hope with such programs is a draw from time to time. You move by entering the number of the square into which you wish to move. According to the book *Computers, their impact and use*, by Robert E Lynch and John R Rice, there are 362,800 possible games of *Noughts and Crosses*, if all games are continued until all spaces are filled.

This program will play some 40,320 of the possible games. You will find the program will run almost without change on a ZX-80, although you will need to change the PRINT arrangements slightly and you will have to delete line 110 completely and replace it with a CL S.

NOUGHTS and CROSSES



```
   1 REM NOUGHTS AND CROSSES
   2 REM ADAPTED T MARTNELL
   3 REM FROM ZX80 PROGRAM
   4 REM BY STUART ROBERTS
  10 DIM B(9)
  20 DIM P(9)
  30 FOR A=1 TO 9
  40 LET B(A)=A
  50 NEXT A
  70 LET E=0
  80 LET Q=0
  90 LET N=0
 100 LET X=4
 110 PRINT AT 5,0;
 120 FOR A=1 TO 9
 130 IF A=X THEN GOSUB 770
 140 IF B(A)=0 THEN GOTO 400
 150 IF B(A)=10 THEN GOTO 430
 160 PRINT B(A);" ";
 170 NEXT A
 180 PRINT
 190 PRINT
 200 IF N=1 THEN GOTO 460
 210 IF E=8 THEN PRINT "I WIN"
 215 IF E=8 THEN GOTO 970
 220 IF Q=5 THEN PRINT "ITS A D
RAW"
 225 IF Q=5 THEN GOTO 970
 230 INPUT Z
 240 IF B(Z)<>Z THEN GOTO 230
 250 LET Q=Q+1
 260 IF Z=11 THEN GOTO 300
 270 LET N=1
 280 LET B(Z)=0
 290 GOTO 100
 300 LET B(5)=10
 310 GOTO 90
 320 FOR A=C TO D
 330 IF B(A)=A THEN LET B(A)=10
 340 LET A=A+F
 350 NEXT A
 360 GOTO 90
 370 IF B(5)=5 THEN GOTO 30
 380 LET B(D)=10
 390 GOTO 90
 400 PRINT "O ";
 410 LET P(A)=1
 420 GOTO 170
 430 PRINT "X ";
 440 LET P(A)=4
 450 GOTO 170
 460 LET H=810
 470 LET G=0
 480 LET C=1
 490 LET D=9
 500 LET F=3
 510 GOSUB H
 520 LET C=3
 530 LET D=7
 540 LET F=1
 550 GOSUB H
 560 LET D=9
 570 LET F=2
 580 GOSUB H
 590 LET C=2
 600 LET D=8
 610 GOSUB H
 620 LET C=1
 630 LET D=7
 640 GOSUB H
 650 LET D=3
 660 LET F=0
 670 GOSUB H
 680 LET C=4
 690 LET D=6
 700 GOSUB H
 710 LET C=7
 720 LET D=9
 730 GOSUB H
 740 LET G=G+1
 750 IF G=5 THEN GOTO 90
 760 GOTO 480
 770 LET X=X+3
 780 PRINT
 790 PRINT
 800 RETURN
 810 LET E=0
 820 FOR A=C TO D
 830 LET E=E+P(A)
 840 LET A=A+F
 850 NEXT A
 860 IF E=3 THEN GOTO 960
 870 IF G=0 THEN RETURN
 880 IF E=8 THEN GOTO 320
 890 IF G=1 THEN RETURN
 900 IF E=2 THEN GOTO 320
 910 IF G=2 THEN RETURN
 920 IF E=5 THEN GOTO 320
 930 IF G=3 THEN RETURN
 940 IF E=1 OR E=4 THEN GOTO 370
 950 RETURN
 960 PRINT "YOU WIN"
 970 PRINT
 980 PRINT
 990 PRINT "DO YOU WANT ANOTHER
GAME?",,"(Y OR N)"
1000 INPUT K$
1005 CLS
1010 IF K$<>"N" THEN RUN
1200 PRINT
1210 PRINT "OK, THANKS FOR PLAYI
NG"
```

```
1 2 3     1 2 3
4 5 6     4 5 6
7 8 9     7 8 9


1 2 3     1 2 3
4 O 6     4 5 6
7 8 X     7 8 9


O 2 3     1 2 3
4 O 6     X O X
X 8 X     7 8 9


O X 3
4 O 6
X O X


O X 3
O O X
X O X
```

ZX81 PERSONAL BANKING SYSTEM WITH LOAD/SAVE DATAFILES AT DOUBLE SPEED

Load the program in the normal way – enter, amend or delete your transactions (ZX81 will automatically scan standing order file and post any items due) – save the file of data onto cassette in 45 seconds – load different datafile into the same program, also in 45 seconds – enter items, etc. – save datafile only onto cassette (45 seconds) – repeat operation for any number of accounts (datafiles).

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There are only two suppliers of supported ZX81 software, this is one of them.

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The Personal Banking System is also available from the Buffer Shop, Streatham, London and Branches of the Computer Bookshop Group, full maintenance still available.

ZX81 MONOPOLY

Occasionally during the life of a Micro a program is written that can go on to become a standard. ZX81 MONOPOLY could be such a program. Most computer simulations are solitary affairs using a program that caters only for one or two players. ZX81 MONOPOLY allows six players to compete with the machine doing all the boring bits, acting as board, rule-book, umpire, dice-thrower and accountant. No cheating is allowed and when required a list of a players properties and the development situation for each can be listed. No need to worry about missing the rent either, your ZX81 is also trained as a rent collector. The program is well driven by a clear MENU at the start of each players turn and after the dice has been thrown. ZX81 MONOPOLY also allows the game to be SAVED with a WINNER so far report. The program requires 16K RAM and comes complete with instructions. Let all your friends and family appreciate the ability of your ZX81 NOW. ZX81 MONOPOLY for 16K at £8.00 inc VAT and postage. Cash with order from the publishers.

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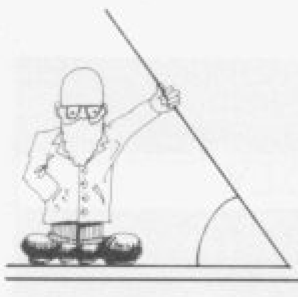
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Finding out about

The trig functions on the ZX-81 are generally regarded as the least used on the machine. Here Ian Stewart looks into the mysteries of SIN, COS and TAN

MY DICTIONARY claims that SIN is moral depravity, COS a curly variety of lettuce and TAN a colour caused by exposure to sun. I can imagine computer programmers engaging in acts of depravity with a lettuce on the Costa de Sol but I doubt if they would admit to it underneath the Q, W, E keys of a ZX-81 keyboard. So that is not the explanation.

They are, of course, FUNCTION keys. What is a function? It is something to which you give a number and then it gives you back another number. Try typing PRINT SIN 1.4423 on your ZX-81 in command mode—it will print you out a number. In general, for any number A, you get back certain numbers SIN A, COS A and TAN A but for what are those outlandish things?

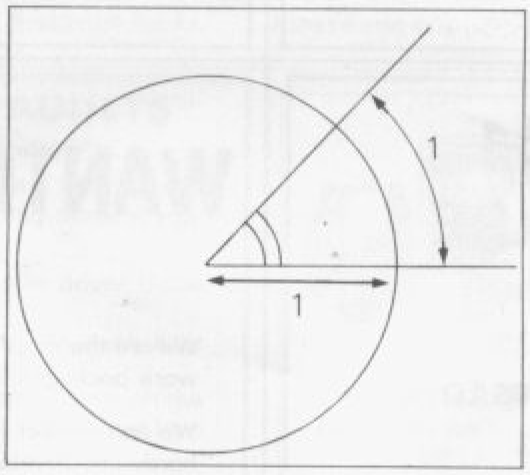
A schoolteacher would call them trigonometric functions, a fussy word for things used to measure triangles. Surveyors use them, of course, but need anyone else bother with them?

The answer is that they must and the reason is that they are very widely applicable. Fortunately, you can learn some of their uses without undertaking an uninteresting course in trigonometry.

Radians

SIN, COS and TAN are really about angles, and angles are fundamental beasts. Straightway we hit the first snag. Sensible people measure angles in degrees, from 0 degrees for no angle at all up to 360 degrees for a full circle. You can go further, say 720 degrees for two full circles—see example. Then a right angle is 90 degrees, a straight line 180 degrees. Cut up a square slice of bread to make two triangular sandwiches and the smaller angles are 45 degrees.

Computers and mathematicians prefer not to measure angles in that way; their favourite unit is the radian. Draw a circle of unit radius; measure unit distance round the edge; that gives you angle of 1 radian.



I will not go into the reasons why this is a good idea but the point is that you must be able to convert from degrees to radians, or back again, to make use of SIN, COS and TAN. The crucial gadget to do it is the number

PI = 3.14159265358 . . .

which is the distance half-way round the edge of the circle. So 180 degrees—the angle half-way round the full 360 degrees—must be PI radians. In consequence:

To convert degrees to radians, multiply by PI/180.

To convert radians to degrees, multiply by 180/PI.

Here are two programs which will illustrate how this works—type them into your ZX-81 and run them. Note that "PI" is key M in function mode; if you type P followed by I the computer will not understand ([] denotes space).

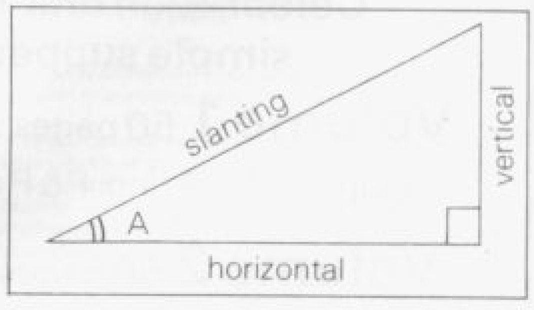
```
10 PRINT " [] [] [] [] DEGREES [] []
   RADIANS"
20 PRINT
30 FOR X=0 TO 90 STEP 5
40 PRINT TAB 4; X; TAB 13;
   X * PI/180
50 NEXT X
```

- -

```
10 PRINT " [] [] [] [] RADIANS [] []
   DEGREES"
20 PRINT
30 FOR Y=0 TO 1.8 STEP .1
40 PRINT TAB 4; Y; TAB 13; Y*180/PI
50 NEXT Y
```

Right-angled triangles

Given a right-angled triangle with an angle A, name the three sides like this:



More formal terms are opposite for vertical, adjacent for horizontal and hypotenuse for slanting. Then, when the angle A is measured, we have:

SIN A = vertical/slanting.
COS A = horizontal/slanting.
TAN A = vertical/horizontal.

So if we know two of the sides and the angle A, we can determine the other side.

For instance, suppose I stand 100 metres away from Nelson's Column and measure the angle to the top at 73 degrees. How high is the column?

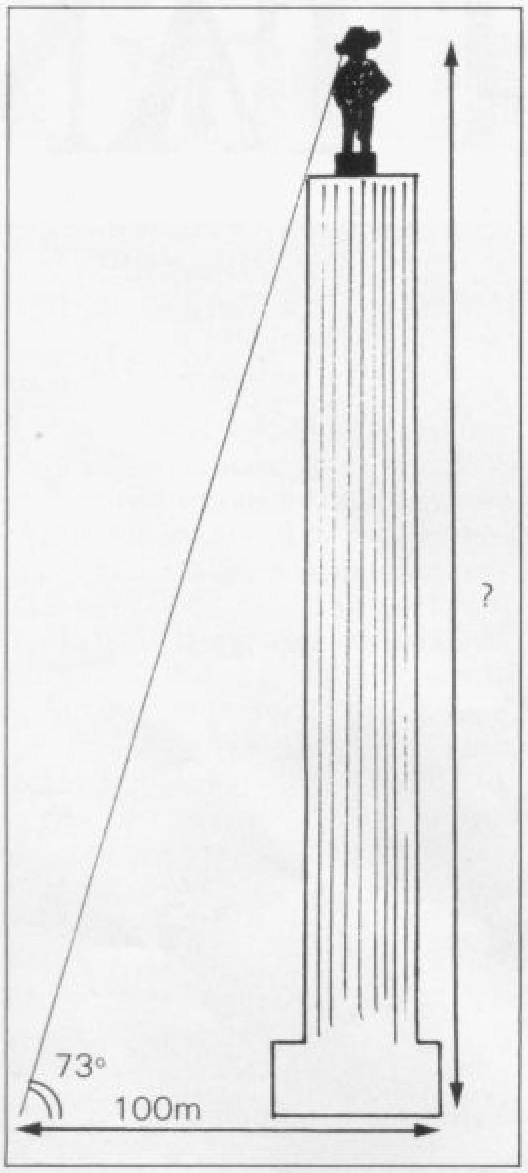
(continued on page 44)

SIN, COS and TAN





(continued from page 42)



We know the horizontal and we want the vertical, so we have to use TAN A = vertical/horizontal.

So

vertical = horizontal × TAN A
= 100 × TAN 73°

We have to use radians, remember? Now 73 degrees is 73*PI/180 radians. So we can find the answer by using the ZX-81 in command mode. Just type

PRINT 100*TAN(73*PI/180).

Do not forget that TAN is key E in function mode, not T-A-N. You should obtain the answer

327.08526.

For some problems like this, you will need SIN or COS instead. For instance, to find the distance between you and the top of Nelson's Column, you need

PRINT 100/COS(73*PI/180)

which is

342.03036.

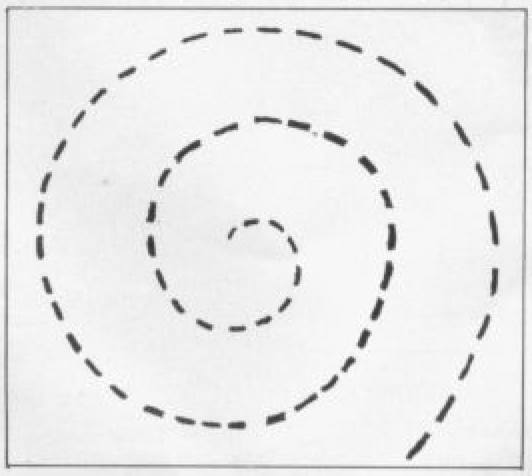


Circles

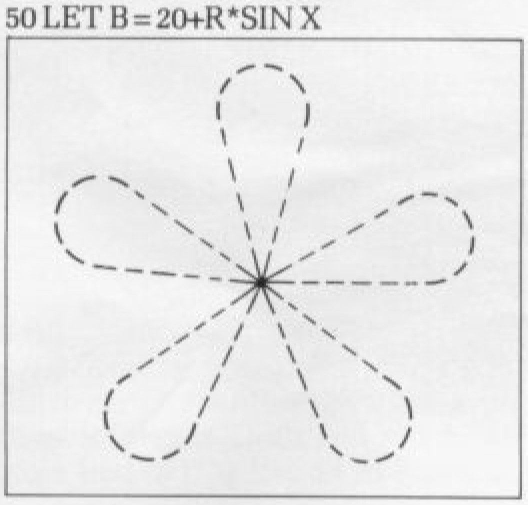
Circles are what SIN, COS and TAN mean but it is not the way in which they tend to be used in programs. Try this program:

```
10 FOR Y=0 TO 360 STEP 10
20 LET X=Y*PI/180
30 LET A=30+20*COS X
40 LET B=20+20*SIN X
50 PLOT A, B
60 NEXT Y
```

What have you? It is a circle. It is a trifle bent because of the coarseness of ZX-81 graphics. The 30s and 20s in lines 30 and 40 are 'cooked' up to get the size and position correct. The centre is at (30, 20) and the radius is 20. Try varying those numbers and see what happens. Change the program a little and you can plot spirals:



```
10 FOR Y=0 TO 720 STEP 10
20 LET X=Y*PI/180
30 LET R=1.5*X
40 LET A=30+R*COS X
50 LET B=20+R*SIN X
```



```
60 PLOT A, B
70 NEXT Y
```

Or you can draw rosettes; just change lines 10 and 30 to

```
10=FOR Y=0 TO 360 STEP 5
30 LET R=20*SIN(3*X)
```

and run. Or change 3*X in line 30 to 4=X, 5*X, 6*X, 7*X . . .

There are many other uses. In the program *Sink the Bismarck* in my book with Robin Jones—*PEEK, POKE, BYTE & RAM!*—we use SIN and COS to calculate the trajectory of a shell fired at a ship.

To end, here are the makings of a kind of roulette game with letters. There are some useful ideas in the program which should have plenty of applications.

Rouletters (©Ian Stewart 1982) [Runs on 1K, ZX-81].

```
10 LET C=0
20 LET D=100*RND
30 LET Q=37
40 FOR I=1 TO 25
50 GOSUB 200
60 NEXT I
70 LET Q=165
80 GOSUB 200
90 FOR T=1 TO 5
100 NEXT T
110 IF C > D THEN STOP
120 LET Q=37
130 GOSUB 230
140 LET I=I+1
150 IF I > 26 THEN LET I=1
160 LET C=C+1
170 GOTO 70
200 LET X=I*PT/13
210LET A=10+10*SIN X
220 LET B=16+10*COS X
230 PRINT AT A, B; CHR$ (I+Q)
240 RETURN
```

● Ian Stewart is a lecturer in mathematics at Warwick University, the author of 20 books, including *Concepts of Modern Mathematics*, *Get Knotted!* and—jointly with Robin Jones—*PEEK, POKE, BYTE & RAM!—Basic Programming for the ZX-81*.

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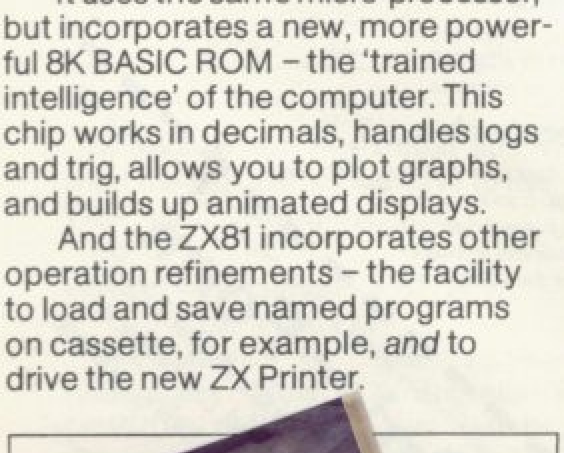
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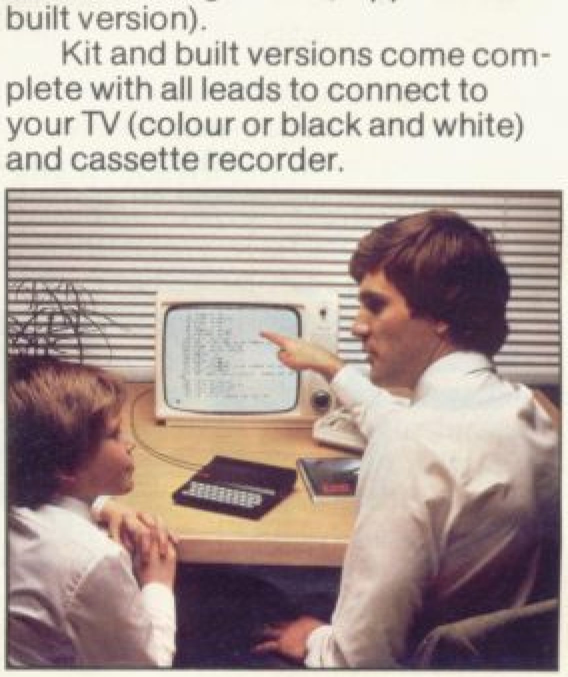
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- Able to drive the new Sinclair printer.
- Advanced 4-chip design: micro-processor, ROM, RAM, plus master chip – unique, custom-built chip replacing 18 ZX80 chips.

Built: £69.95

Kit or built – it's up to you!
You'll be surprised how easy the ZX81 kit is to build: just four chips to assemble (plus, of course the other discrete components) – a few hours' work with a fine-tipped soldering iron. And you may already have a suitable mains adaptor – 600 mA at 9 V DC nominal unregulated (supplied with built version).

Kit and built versions come complete with all leads to connect to your TV (colour or black and white) and cassette recorder.



uter-



Available now- the ZX Printer for only £49.95

Designed exclusively for use with the ZX81 (and ZX80 with 8K BASIC ROM), the printer offers full alphanumerics *and* highly sophisticated graphics.

A special feature is COPY, which prints out exactly what is on the whole TV screen without the need for further intructions.

At last you can have a hard copy of your program listings – particularly useful when writing or editing programs.

And of course you can print out your results for permanent records or sending to a friend.

Printing speed is 50 characters per second, with 32 characters per line and 9 lines per vertical inch.

The ZX Printer connects to the rear of your computer – using a stackable connector so you *can* plug in a RAM pack as well. A roll of paper (65 ft long x 4 in wide) is supplied, along with full instructions.

16K-byte RAM pack for massive add-on memory.

Designed as a complete module to fit your Sinclair ZX80 or ZX81, the RAM pack simply plugs into the existing expansion port at the rear of the computer to multiply your data/program storage by 16!

Use it for long and complex programs or as a personal database. Yet it costs as little as half the price of competitive additional memory.

With the RAM pack, you can also run some of the more sophisticated ZX Software – the Business & Household management systems for example.

How to order your ZX81

BY PHONE – Access, Barclaycard or Trustcard holders can call 01-200 0200 for personal attention 24 hours a day, every day.
BY FREEPOST – use the no-stamp-needed coupon below. You can pay by cheque, postal order, Access, Barclaycard or Trustcard.
EITHER WAY – please allow up to 28 days for delivery. And there's a 14-day money-back option. We want you to be satisfied beyond doubt – and we have no doubt that you will be.

To: Sinclair Research, FREEPOST, Camberley, Surrey, GU15 3BR. Order

Qty	Item	Code	Item price £	Total £
	Sinclair ZX81 Personal Computer kit(s). Price includes ZX81 BASIC manual, excludes mains adaptor.	12	49.95	
	Ready-assembled Sinclair ZX81 Personal Computer(s). Price includes ZX81 BASIC manual and mains adaptor.	11	69.95	
	Mains Adaptor(s) (600 mA at 9 V DC nominal unregulated).	10	8.95	
	16K-BYTE RAM pack.	18	49.95	
	Sinclair ZX Printer.	27	49.95	
	8K BASIC ROM to fit ZX80.	17	19.95	
	Post and Packing.			2.95

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*Please charge to my Access/Barclaycard/Trustcard account no.

*Please delete/complete as applicable.

Please print.

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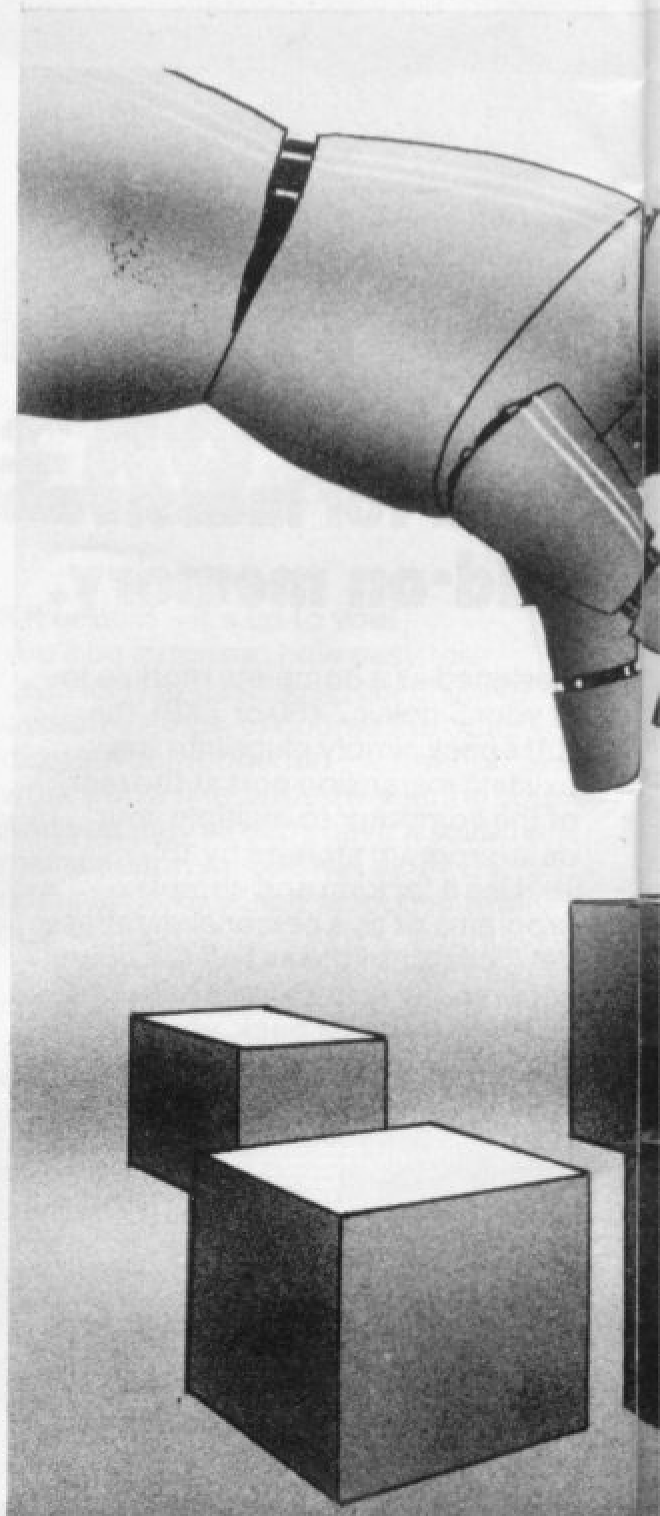
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Easy to as powerful

Mike Biddell begins a series of articles aimed at explaining—in the simplest



I LEARNED machine code in the school of hard knocks, clutching my Mostek Z-80 programming manual, which is now very tattered, and the Nascom-1 documentation, which was not particularly helpful. They were heady pioneering days but this series of articles is designed to take you through the machine code hoops, so that your cranium does not suffer too much pain. It will start with first principles and culminate in the production of a machine code-based game.

Why make the effort to learn machine code? Three main reasons spring to mind:

It is faster in operation than the equivalent Basic program.

It occupies much less space in the memory than the equivalent Basic program—that is critical on the unexpanded ZX-81.

It gives greater scope for the imagination than Basic. With Basic you are tied to the menu of instructions the manufacturer has given you in the brain—ROM—of the computer. With machine code, you can make the operating system do things outside the set menu, make the screen scroll printed information downwards—the Sinclair menu gives only a scroll up.

So machine code can be packed tighter, run faster and produce more imaginative effects outside the manufacturer's original Basic instruction set.

Machine code is a set of numeric instructions, called bytes—eight zeros or ones in any combination—which, when addressed to the Z-80 chip central processing unit, make it perform some sensible function. The Z-80 would not understand a Basic instruction, such as PRINT, directly. A very complex piece of machine code called the Basic Interpreter breaks PRINT into numeric instructions for the Z-80 chip to produce the required effect from the command PRINT.

Those hexadecimal codes—number base 16 for convenience—are listed under Z-80 Assembler in the ZX-81 Manual—pages 181 to 187.

It seems a little daunting but really the fundamental things you can tell the Z-80 chip to do are really simple but the overall effect can be very powerful

Here is a summary of the main things you will ask the Z-80 to perform during a machine code program; you ask it by simply feeding it the appropriate code.

- Add one to the contents of a register—called increment. A register is somewhere in the chip where you can hold a number/value to do something with it.
- Take one away from the register —decrement.
- Save the contents of the register elsewhere, so you can use that register for something else—Push.
- Bring back the saved value into the register—Pop.
- Carry-out a machine code routine somewhere else, then return to the same point in the program—Call and Return.
- Jump backwards or forwards a number of instructions if a register or part of a register is not zero—Jump Relative No Zero.
- Jump backwards of forwards a number of instructions if a register or part of a register is zero—Jump Relative Zero.
- Load registers with specific numbers.

They do not appear to be the building bricks of computing power, but they are.

To put machine code into a ZX-81, write a single-byte instruction to an address in the memory. The POKE instruction takes the general form:

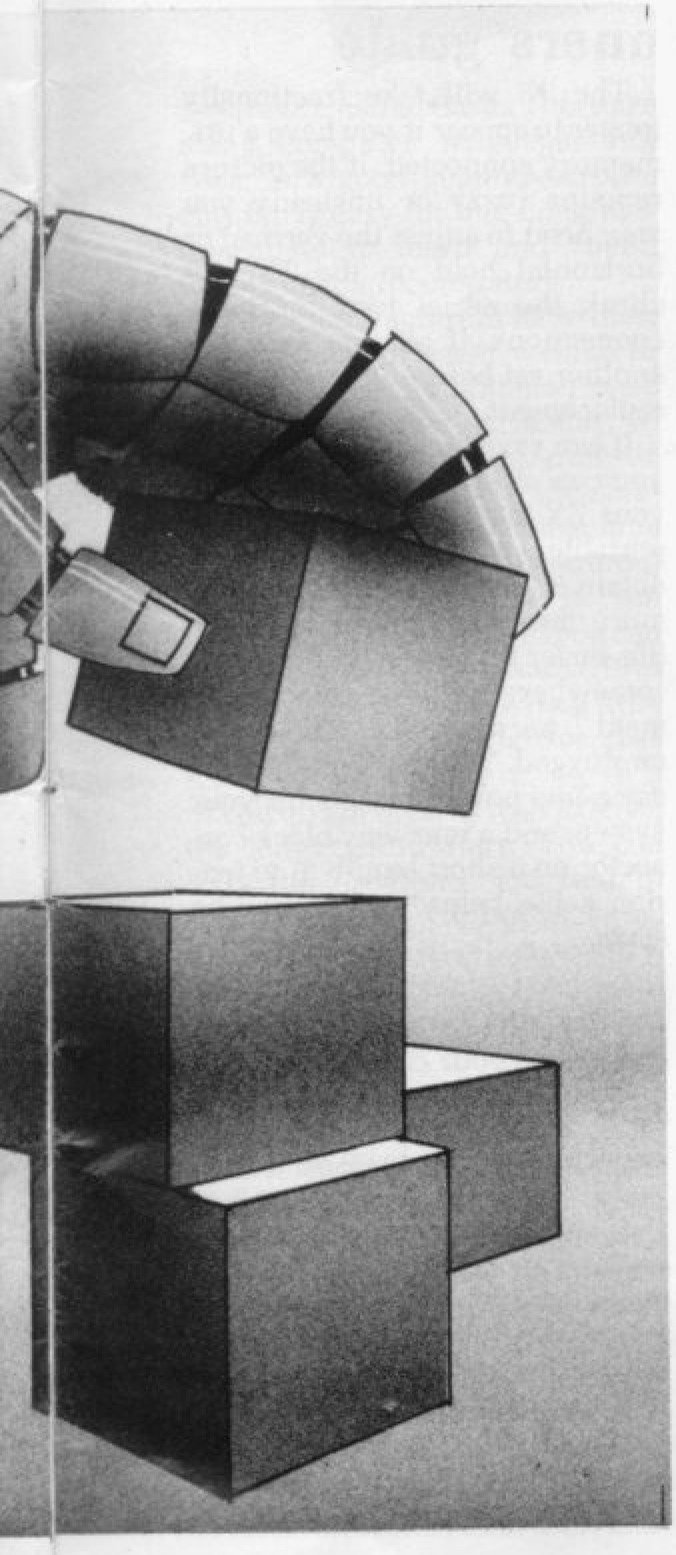
POKE 16514, 12
Address Instruction Code

The POKE instruction operates on decimal numbers, so that all the hexadecimal codes must first be converted to decimal before POKE-ing them into the computer memory. The decimal code 12 instructs the Z-80 chip to increment—add one—to its 'C' register.

The most suitable place for the code, it is generally agreed, is within a REM statement placed at line 1 of the program. The machine code loader—figure one—POKE your machine code into spaces after the REM statement—addresses 16514 onwards.

assemble
...l bricks

possible terms—the advantages of programming in machine code.



So sit at your ZX-81 keyboard, switch on and type it in. There are approximately 100 letter Ms after the REM statement, to reserve space for machine code.

When the program is in, run it, then type POKE 16514, 128; do not use a line number—this is called POKE IMMEDIATE—and remember that POKE is entered by pressing the letter O key once. What you then see is that the first letter M after the REM statement has changed to a black square. The reason is that although 128 is the Z-80 op. code for adding the contents of the A and B registers in the Z-80 chip, it is also the ZX-81 character code for a black square.

The computer tries to display any number POKEd into the display file. Then try the following:

POKE 16514, 124

The black square will have vanished and a question mark is displayed. That is because code 124 is not a character code, so the computer displays a question mark instead. Then we can enter our first machine code program but previously we call a machine code program, using the USR function and the Basic statement as follows:

e.g. 10 LET A = USR (16514)

That tells the program flow to jump to and execute the machine code routine, starting at address 16514. An additional piece of information which can often be used to advantage is that the value given to A is the same as that contained in the B and C registers, combined, of the Z-80 chop.

To get back from machine code routine you must end the routine with the code for RETURN—i.e., 201. Then enter the following simple program, using the loader:

Decimal	Nemonic	Comment
1 1 0	LD BC, 01	Load the BC register pair with the Value 1
201	RET	Return to the Basic programme

Run the machine code loader then enter 1 Newline, 1 Newline, 0 Newline, followed by 201 Newline. You will then see in the REM statement two small black squares, followed by a space, followed by TAN—all is then well.

Then delete lines 4, 5, 20, 30, 40 and 50 from the program and add lines 3, 10 and 20—figure two.

If you then run the program shown in figure two, a figure 1 will appear on the screen. That shows that your first machine code program has run correctly. You have loaded the BC register pair with the value one, the program has returned from machine code to Basic successfully and printed the value of A, which is the value contained in the B and C registers as a pair.

Those then, are the rudiments of machine code writing for the ZX-81 and from these humble beginnings much can be developed.

Figure 1.

```
   1 REM MMMMMMMMMMMMMMMMMMMMMMMMMM
MMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM
MMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM
MMMMM
   3 LET T=16514
   4 CLS
   5 LIST 1
  20 INPUT C
  30 POKE T,C
  40 LET T=T+1
  50 GOTO 4
```

Figure 2.

```
   1 REM ▀▀ TAN MMMMMMMMMMMMMMMMMMMMM
MMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM
MMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM
MMMMMMMMM
   3 LET T=16514
  10 LET A=USR (T)
  20 PRINT A
```

What to do now you have bought your Sinclair

Don't panic! Here is the *Sinclair User* beginners' guide

SO YOU have taken the plunge and bought your ZX-81—now what? You may have a specific use for the machine in mind or you may simply be fascinated by the prospect of owning your own computer and keen to learn more about it. Here are a few general hints to help you.

Don't panic

If all you know about computers so far is that they usually try to take over the world in science fiction films, do not worry. The ZX-81 was designed for you. You do not have to be a genius or a mathematical wizard to use it. This computer was made with the beginner in mind and will let you learn in easy stages and take you on to advanced computing.

The ZX-81 is fairly robust and tolerant of mistakes, so nothing you do to it in ordinary use will cause any damage to it, or to your television or cassette recorder.

You can enter anything you like from the keyboard; it will not necessarily work but it certainly will do no harm. If the worst happens and you find strange pictures on the screens, or the keyboard will not respond, you pull out the power plug, wait for a second or two, plug it back and your machine is as good as new.

Remember only to do that as a last resort, because you will lose everything you have typed-in. The programs you put in will stay there only while the power is on.

Setting up

The instructions for setting-up your computer on page seven of the manual are reasonably comprehensive and you should normally have no problems. It is worth checking, if you have just opened the box, to make sure you have all the correct pieces— a ZX-81, a power supply unit, a manual, an aerial lead and a pair of cassette leads. Connect up, turn on the power—remembering to keep the TV volume low to save your eardrums—and tune to channel 36UHF. You may have slight difficulty locating the UHF tuner on your TV because some manufacturers manage to conceal it fairly skilfully. If you have a push-button model, switch to an unused channel and turn the push button.

On other models the tuner is at the back of the set or sometimes in a pull-out tray at the front. Once you have tuned-in, you should see a black square in the corner of the screen with a white 'K' like the picture in the manual. If the 'K' does not appear, double-check that you have everything plugged-in to the correct sockets and that power is on, then re-set the machine by unplugging the power for a second or so and try tuning again.

The 'K' will take fractionally longer to appear if you have a 16K memory connected. If the picture remains fuzzy or unsteady you may need to adjust the vertical or horizontal hold on the TV and check the aerial lead for loose connections. If all that fails, try another set before you send for a replacement.

It can save family arguments if you can afford a separate TV for your ZX-81; you can buy a cheap portable set for around £50 or obtain a second-hand one even more cheaply. Similarly, it makes life easier if you can find a corner somewhere to leave your equipment permanently set up—unplugged. You will find that you use a few power sockets for your system and a four-way block connector on a short length of extension cable helps to tidy trailing leads.

Talking to your ZX-81

The ZX-81, like a pocket calculator, 'understands' numbers and signs like plus and minus. It is far more sophisticated, however, than a calculator and can also cope with letters and words—those on the keyboard—provided they are presented in the proper way.

A calculator follows the rules of arithemtic; the ZX-81 uses an artificial language designed for



computers, called Basic. There are many computer languages but Basic is a good general-purpose one, fairly easy for non-computer specialists to learn and found widely on microcomputers.

Most manufacturers have their own slightly different version or dialect of Basic and Sinclair is no exception. What this means, in practice, is that a program—a series of instructions to the computer—written for one machine will not work on another without some modification but if you understand Sinclair Basic you can soon learn the minor peculiarities of other versions and, with a little practice, adapt them for the ZX-81.

You do not need to wait to learn the language to start. You can copy the programs you find in *Sinclair User*. A word of warning. Make sure you copy them exactly. You may understand a sentence with a comma or a quote omitted but your ZX-81 relies on those cues and the program will not work without them.

For that reason, it is a good idea to SAVE a program on cassette tape before you press RUN and NEWLINE to make it work. That way, if you have made a mistake and you lose the program from the computer, you can LOAD it back quickly from the tape and look for the error, without having to type it in from the beginning.

You can also buy a wide variety of commercially-produced, pre-recorded programs on cassette. They can vary a good deal in quality and you will need to read the reviews and use your judgment to choose the best.

A good deal of the interest and fun of having your own computer is in writing your own programs, which is easily as fascinating as playing even the best game of *Space Invaders* written by someone else. The manual deals thoroughly with Sinclair Basic but if you find it heavy going or not to your taste, there are plenty of books available for the ZX-81. Check your local bookshop and find one which suits you.

Many people feel that the best way to learn is to plunge in at the deep end and see what you can make the computer do. Refer to the manual if you have difficulties. You can ignore the functions and calculations initially and experiment with PRINT statements to get the feel of your machine. The beauty of having your own computer is that you can learn at your own pace in the style which suits you best.

Keeping your programs

You lose the program contents of your computer when you turn off the power but you can take a copy of the program, because the ZX-81 can reproduce the instructions you have typed-in as a coded sound signal which you can record on to ordinary cassette tape. When you want to use the program you play it back to the ZX-81 and it translates the coded sound back as your program.

To record a program, you SAVE it and to play it back you LOAD it. Chapter 16 of the manuals tells you in detail how to do it. You may have problems occasionally in LOADing, usually with tapes recorded by other people. One way to deal with that is to wind the tape to the middle of the program and type LOAD " " followed by NEWLINE, then slowly turn up the volume of the recorder with the tape running until the television screen shows four or five horizontal black bands. If you then re-wind the tape, the program should load normally at the volume setting.

Carry on computing

Finally, a health warning. Apart from any practical uses, computing with your ZX-81 can be a very entertaining hobby and is almost certainly habit-forming. You may easily find yourself crouched over your machine, red-eyed, in the early hours of the morning, thinking that in another five minutes you will sort out the problem. Try to break that habit by getting into the fresh air and meeting other Sinclair users; it undoubtedly will help your programming—and your non-computing friends, poor souls, will probably be sick to death of hearing about computers by that time in any case.

By getting a ZX-81 you will find you have joined a not very exclusive club with many thousands of members, many of whom would be only too happy to advise you if you have problems. *Sinclair User* will help you to get in touch with other users by printing a list of clubs each month.



On the production line



A piece of cake in Dundee

Lynd Church goes to Scotland to discover just how the ZX-81 is manufactured

IN KEEPING with its philosophy of sub-contracting all manufacturing processes, Sinclair Research appointed Timex to produce the ZX-81 when it was introduced in March, 1981.

Since that time, production at the Timex plant at Dundee has increased from 10,000 to 60,000 units per month, while production of the Sinclair printer, also in the Timex factory, is now running at 15,000 units per month.

David Chatten, production controller with Sinclair, explained that although the company does not undertake its own manufacturing, it is very thorough in its analysis of prospective component manufacturers. "We get people who are good at manufacturing particular components, then get everything assembled in a good production plant", he said.



David Chatten

The rate of growth of units produced at Dundee not only reflects the success of the ZX-81 but also justifies Sinclair confidence in Timex, a company which had little experience in the assembly of electronic equipment.

Allan Johnston, project manager of board assembly at Timex, explained that the company decided to expand into new technology when watch technology began to change. He said: "Our experience at Dundee was in mechanical watches but development in quartz and digital technology led us to consider expansion into other areas".

So Timex and Sinclair began discussions on the production of the



Allan Johnston

Sinclair flat-screen tube and Microvision pocket TV, for which Sinclair has announced a £5 million four-year capital investment programme. Because Timex had no experience in electronic assembly, it was decided that the production of the ZX-81 would be a first step in the learning process, added to which Timex was prepared to make the capital outlay for equipment needed for such assembly.

Chatten also stressed that assembly staff at Timex are of very high calibre, the best of whom were, initially, taken off-line to train in ZX-81 assembly. Chatten added:

(continued on page 54)



(continued from page 53)

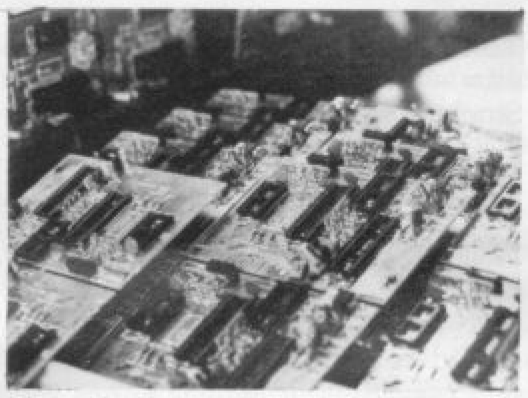
"Getting Timex to do the assembly on the ZX-81 may have been a risky decision in the short term but in the long term it provides us with considerable security, giving us the



Building up the circuit board

opportunity to build good working relationships before full production on the pocket TV begins".

Whatever the risks, production of the ZX-81 seems to be proceeding smoothly, with only minor difficulties still to be solved, according to Chatten. The process starts with the build-up of the printed circuit board, including the addition of diodes and resistors. The board then goes through a flow-solder machine,



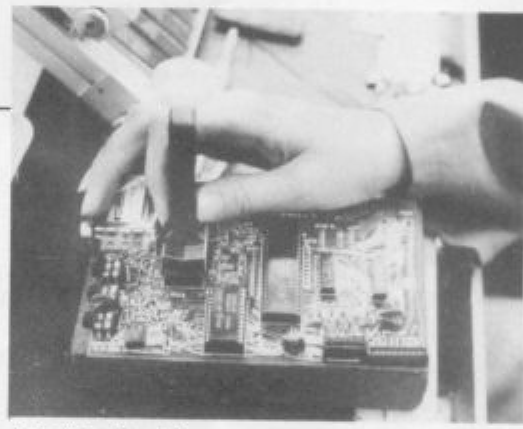
After soldering

which solders all the components into place and includes a cutter to tidy the leads.

It is only at that point that the chips are added to the board. They arrive at the Timex plant in anti-static tubes and are fed into a slide dispenser to ease the process of manual assembly. It is at that point that the first test of the equipment is made.

Bearing in mind that the assembly process has not then reached the keyboard stage, the test is to establish that the board is alive and well. It is called the K test, because all it requires is the appearance of the K on the screen, notifying the user that the machine is ready for instructions.

If a board fails the K test, it is then tested on a GenRad 2270 which



Inserting the chips

identifies the fault and produces a printout denoting the area at fault. The printout is then attached to the board, which is returned to the re-work section, before going through the entire process again.

Assuming that the board has passed the K test, the top half of the casing with the touch-sensitive keyboard and connectors is assembled. At that point, the ZX-81 is again tested, running off a test program on cassette which will display a series of OKs on the screen for every key tested.

Finally, the bottom half of the casing is attached and the completed ZX-81s are packaged for distribution.

There are three main avenues of distribution—Jaserve, a fulfilment house which deals with mail order; Griffin and George, school suppliers; and the W H Smith distribution



Testing for faults

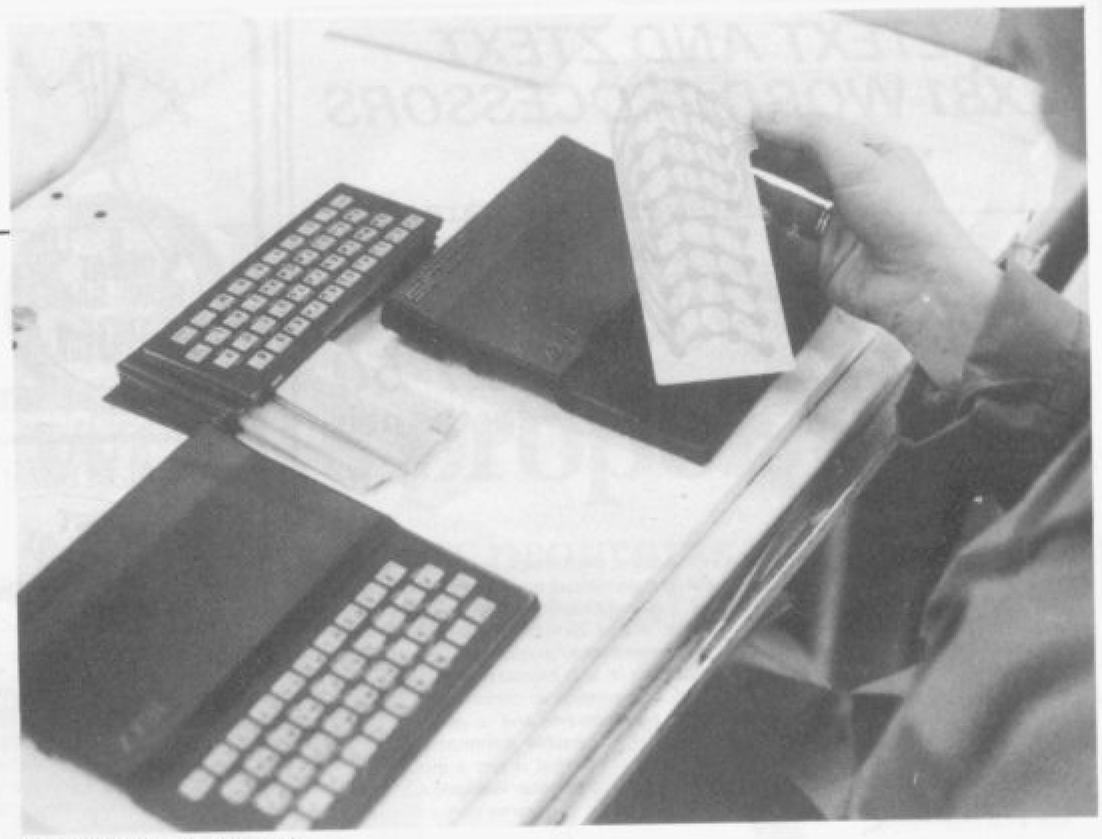


centre at Dunstable, Bedfordshire. Timex has also agreed recently with Sinclair to market personal computers, peripherals and software in North America.

Distribution for them will be handled by established Timex shipping agents, distribution network and retail outlets in the U.S., though Sinclair will continue to sell the ZX-81 by mail order from its Boston-based subsidiary until Timex sales have reached agreed targets. At that stage Sinclair will begin to concentrate on sales of its yet-to-be-released flat-screen TV.

The machines in North America will be marketed under both Sinclair and Timex names and Sinclair will receive a royalty on all sales under the agreement, which covers current and future Sinclair personal computer products and Timex developments of Sinclair computer technology.

Timex obviously has a fair amount of confidence in the product it is assembling for Sinclair, demonstrated by its use of the ZX-81 to test the printed circuit board of the Nimslo 3D camera, assembled by Timex and soon to be marketed in the U.S.



Assembling the keyboard

Sinclair believes that such confidence is well justified, pointing to what it considers to be a low percentage of returned equipment. The return figure on the ZX-81 is 2.4 percent, though the percentage return on kits is higher, at around 13 percent.

Chatten claimed that the higher figure of kit returns is due more to poor component insertion and bad soldering than to component failure but stressed that if any component failure is found, the £10 which kit customers have to pay for a ZX-81 to be serviced is returned.

He admitted that of the 2.4 percent returns of supplied ZX-81s, around one percent of failure is due to power supply faults, an area in which Chatten believes there could well be



Finished printers

improvement. In fact, it is Clive Sinclair's stated aim for a return percentage of one percent overall and it is partly to that end that he recently appointed a quality assurance manager, David Fuller.

While an aim for continued improvement in machine reliability is a necessary part of successful business practice, the gamble of engaging a company with little experience in electronic assembly seems to be paying-off. Chatten commented:

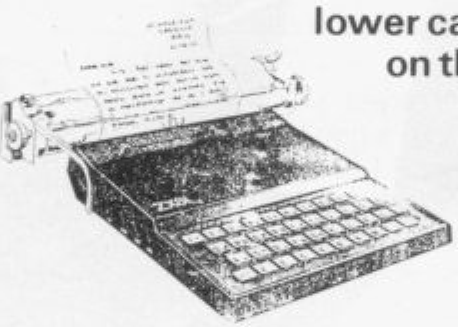
"There is some room for improvement in the assembly process—perhaps greater use of automated production lines—but on the whole we are very pleased with Timex work".



Testing the keyboard

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lower case characters on the ZX printer!!



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Send 95p (redeemable against first order) for full catalogue and FREE listing. Please state ZX81 on order.

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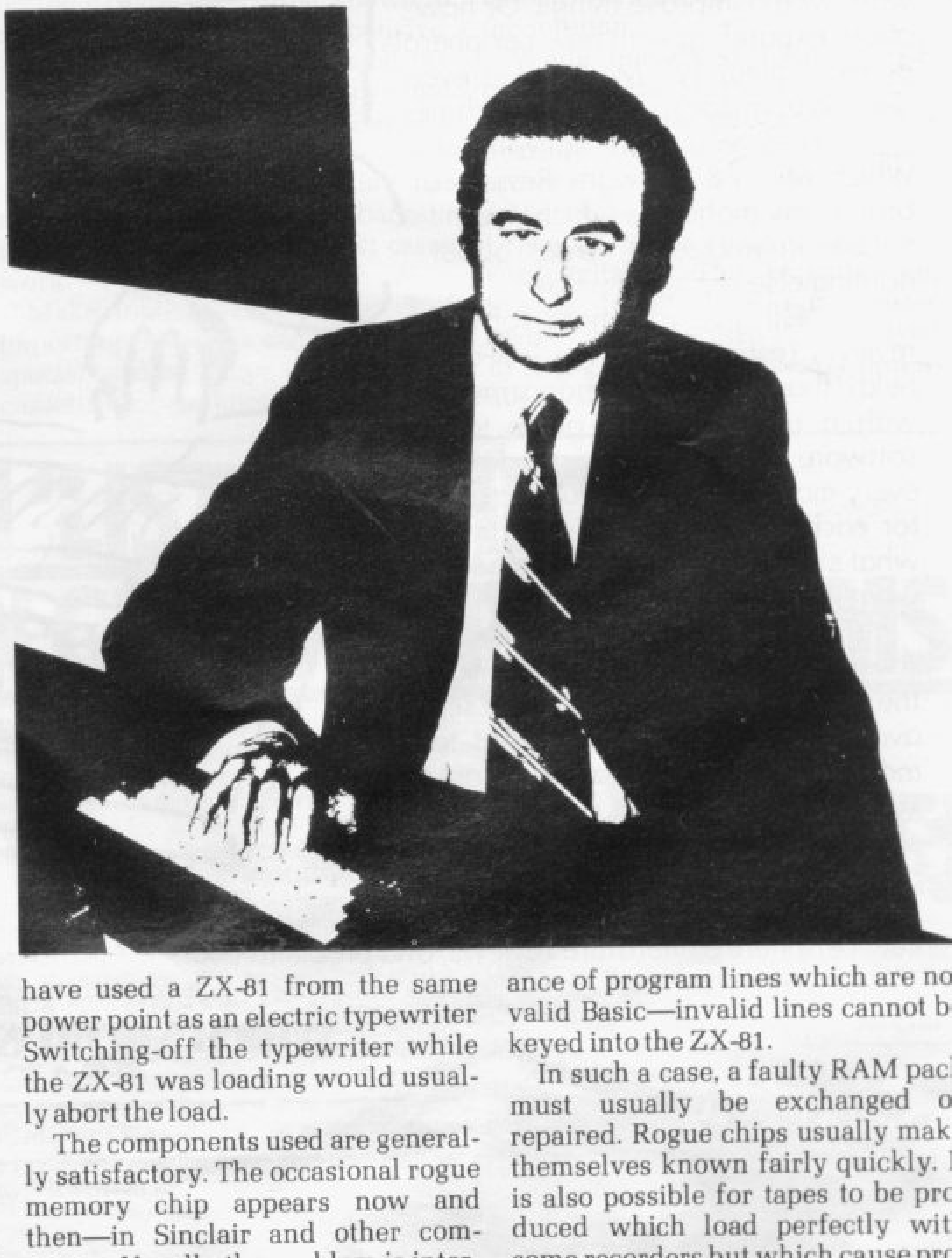
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Making sure it works properly

To run business programs, the machine must be reliable, writes Mike Salem.



ANY COMPUTER which is to be used in real applications must be reliable. The ZX-81 has a less then perfect reputation in that respect but all the problems can be solved; we will see how.

Essential requirements for any computer are that all calculations must be done correctly; that the contents of memory must be stored without being corrupted or vanishing entirely; that it must be possible to store programs and data reliably and to load programs and data generated by a properly-set-up system.

The correctness of calculations is almost entirely dependent on the program. It is possible for hardware design errors to occur which cause odd problems but they are usually found and corrected by the manufacturer relatively soon after the release of a new machine.

The ZX-81 had such a problem; early machines did things such as 3 – 0.00000000000001 = 7 and 0.25**2 = 3.1423844. That was soon corrected and the old machines were repaired. Even the giants of the computer industry are not free from such problems.

Computers also have idiosyncracies which must be understood by programmers; many computers can obtain a number such as 3.9999999 by adding 0.1 + 0.1 + . . . repeatedly. If the program then tests whether the answer is 4, or takes the integer part, the result will not be what is wanted —that is the programmer's responsibility.

It is easy to design a computer without the particular feature just described but that adds to the cost or decreases the capacity to store numbers. The ZX-81 has a very good version of Basic. The handling of text information, in particular, is better than most micros, including some very expensive ones.

The integrity of data depends on the design of the machine and the reliability of components and connections. The electrical design of the ZX-81 is, in general, good; it is vulnerable, however, as are most microcomputers, to strong electrical interference on the mains supply—I have used a ZX-81 from the same power point as an electric typewriter Switching-off the typewriter while the ZX-81 was loading would usually abort the load.

The components used are generally satisfactory. The occasional rogue memory chip appears now and then—in Sinclair and other computers. Usually the problem is intermittent. The chip is perfect when tested but causes trouble on warming-up. The presence of a faulty chip may be revealed by, say, incorrect letters appearing here and there in a program, or by the appearance of program lines which are not valid Basic—invalid lines cannot be keyed into the ZX-81.

In such a case, a faulty RAM pack must usually be exchanged or repaired. Rogue chips usually make themselves known fairly quickly. It is also possible for tapes to be produced which load perfectly with some recorders but which cause program corruption similar to that produced by faulty memory chips—or simply refuse to load—with others.

That is more common with duplicated tapes than with recordings

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direct from the ZX-81. In the short term, reliability is improved by loading at the highest possible level. In the longer term, such tapes must either be re-recorded by the user or replaced by the supplier. The choice is the user's.

The most serious problem with the ZX-81 has been the sudden loss of all the contents of memory. That is due almost invariably to the connection between the ZX-81 and the Sinclair RAM pack. The RAM pack plugs into the ZX-81 but has two feet; when the keyboard is used the RAM pack and the ZX-81 move slightly, relative to each other. One of the 43 connections may be interrupted momentarily, with catastrophic consequences for the contents of memory.

A number of ways of circumventing the problem have been published—we will not repeat them. The best solution is to use a RAM pack which employs a tight connector of high quality with gold-plated contacts and which does not in anyway touch the surface supporting the ZX-81.

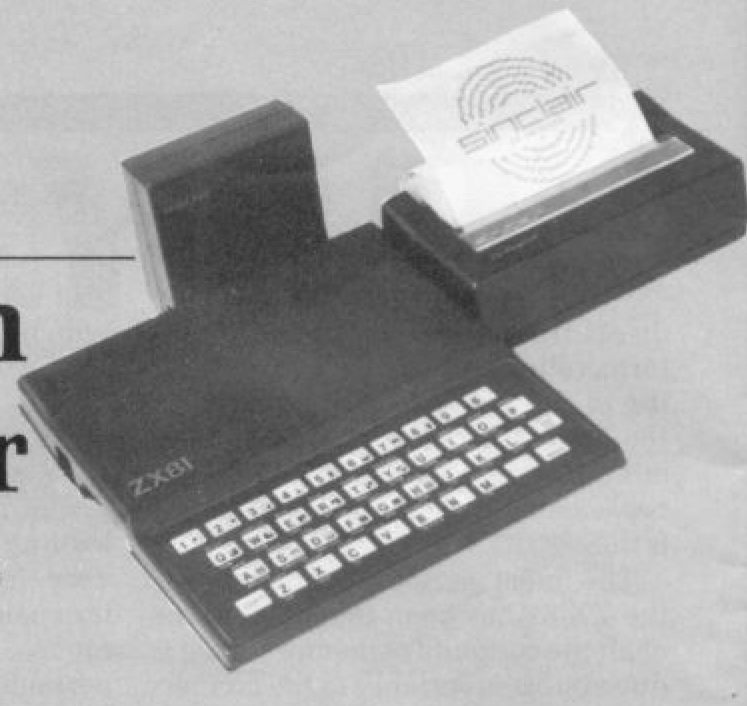
The final problem is saving and loading programs. That can be done very reliably using simple and inexpensive equipment and techniques. Use a mono—not stereo—portable cassette recorder known to be suitable; it need not be expensive. Try to adjust, or to have adjusted, the head azimuth angle. Make sure that your leads are in good condition. Use good quality tape, C60 or shorter—special computer tape is not necessary—but do not use bargain tape, although it will in most cases work.

Make duplicate back-up copies of important programs and data. Use a special loading meter when loading cassettes of unknown properties. Clean the heads frequently and check them for wear as this is a problem.

One or more ZX-81s can be used as dedicated machines, running 24 hours a day. Occasional tape back-ups should be made—the recording can be started just before a tea break, for example. If the power supply is less than 100 percent reliable, 8V worth of heavy-duty re-chargeable battery, with trickle charger, will be the solution.

While the ZX-81 becomes perceptibly warm, overheating does not seem to be a serious problem; it is possible to use a true 8V supply, rather than the 9V nominal, 11V actual of the ZX-81 supply.

The ZX-81 can be made to operate very reliably. The expense and trouble involved is not great—certainly far less than that involved in living with an hopelessly unreliable system.



Write a program and win a super Sinclair printer

Thank you for your entries in our first competition . . . the lucky winner of a Sinclair printer will be announced next month.
The prize is the same in this month's competition. And all you have to do is to submit the best NON GAMES program. And because you can use up to 16K all entries must come in on cassette.
The closing date is May 12.

Fill in the entry form below and while we will accept a cassette it must be accompanied by a well-typed or beautifully hand-written listing.
Your entry must reach us by May 12.

As a tie-break—if one is necessary—we want you to write a slogan beginning with the words: 'I love my ZX-82 because . . . .'.
The usual rules, about the editor's decision being final and employees of ECC Publications being ineligible, apply.

ENTRY FORM

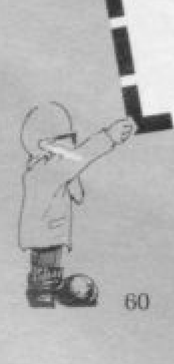
Complete this slogan which will be used as a tie-break: I love my ZX-81 because. . . . . ,

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. . . .

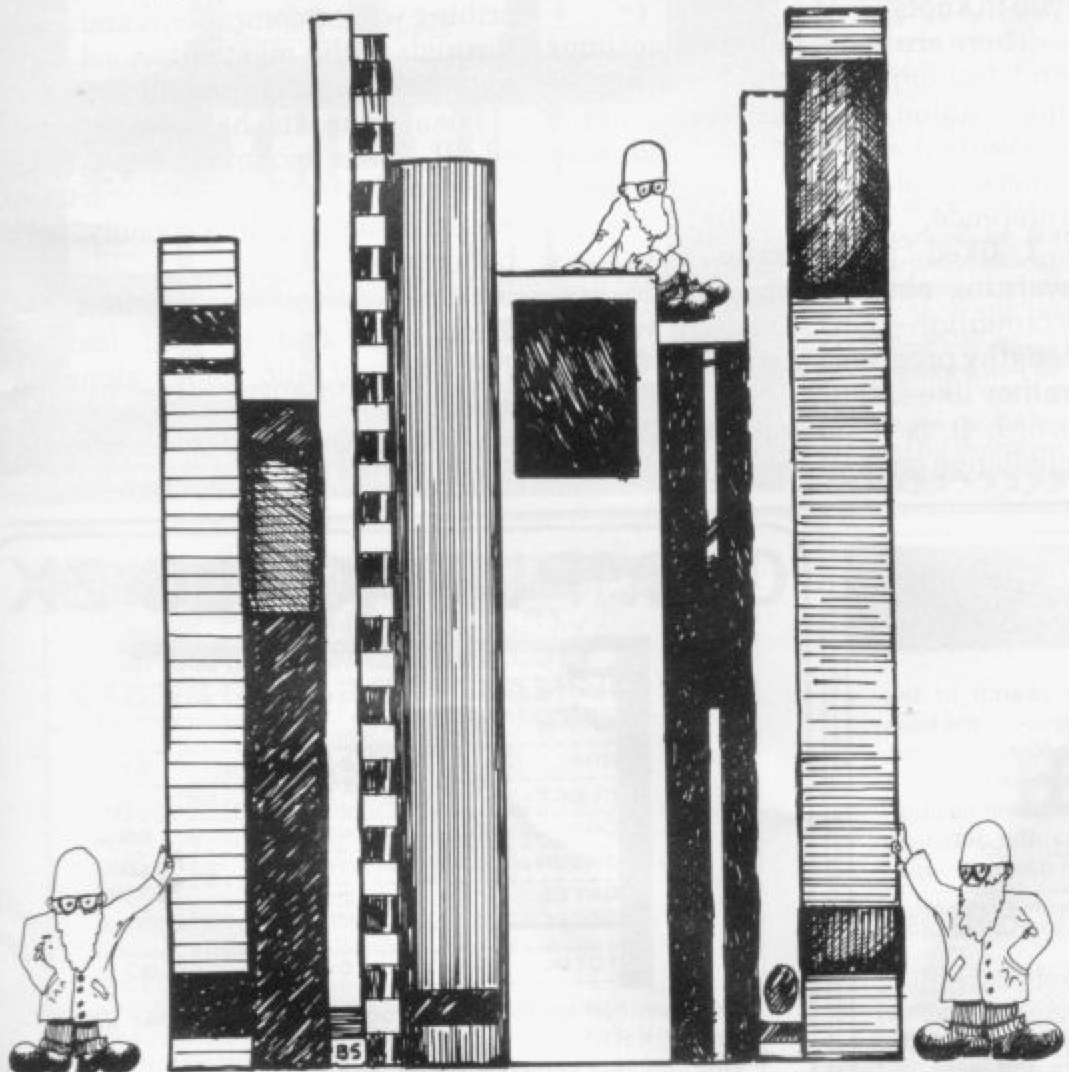
Send your entries to ECC Publications, 30-31 Islington Green, London N1 8BJ to arrive not later than May 12.





A teacher's view of the Sinclair

Another batch of books comes under the scrutiny of reviewer Tom Vests



SOME PEOPLE cannot help taking their Sinclair micros seriously, while others find it necessary to inject elements of humour and occasionally farce into their dealings with the machine.

It is a tradition dating from the early days of the big mainframe computers. Computer people then were sharply-divided into two groups. One resembled the popular view of a trainee bank manager, while the other was a band of cheerful or manic individualists. Both groups produced equally good ideas and programs.

Those Sinclair enthusiasts who are writing books on the machines have already divided into the traditional groups. While this reviewer prefers the exuberant individualists, it is all a matter of style. People who approach programming seriously derive just as much pleasure from it as those who take it in the spirit of Monty Python's Flying Circus.

Publishing house Macmillan leaves no doubt as to the approach of Randle Hurley's book with the title, *The Sinclair ZX-81—programming for real applications*. Other computer titles from Macmillan include three manuals on Basic programming and one on digital techniques.

Hurley has aimed his book at someone who is not a computer expert and who has read the Sinclair manual without understanding some of the more esoteric functions and techniques completely. More significantly he adds that the reader may be a teacher, as he is himself.

The programs and techniques are based on his experience with the ZX-81 at his school. He assumes that the reader has the 16K RAM pack with the machine.

It is not a book for the small businessman or club secretary who wishes mainly to have a system up and running and to acquire a little programming technique on the side but it is one for anyone who wishes to extend their knowledge of the Sinclair and wishes to make use of it in a practical way. It would certainly be useful for any teacher who wished to make use of a Sinclair.

The tone overall is schoolmasterish in the best sense. Hurley lets you know what he intends to do and then shows you how to do it. At the beginning he provides a large number of tips on how to approach programming, particularly on the most difficult part of all in writing long programs—how to keep track of what you are doing.

He blasts through them at a rapid rate to reach the heart of the matter, programming techniques; many users will probably find themselves back-tracking to pick up that wrinkle on program documentation they had forgotten but no-one will be able to say that they were not warned.

Programs of particular interest to teachers include rank ordering, examination results analysis and a reading age program to accompany the low-grade word processing system. Hurley promises a more useful version of the latter in a book being prepared on ZX-81 machine code.

The programs and the listings all illustrate useful techniques and the lines of program code are explained comprehensively, line-by-line—a major plus in books on the Sinclair.

In keeping with his aim of having the reader push the ZX-81 much

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further than anyone expected when it was launched, Hurley offers a number of hardware modifications in the last chapter. They are a modified power supply, extra money and hooking the Sinclair to a standard keyboard. They are not for the electronically-illiterate and require the ability to read and understand a circuit diagram, as well as to solder neatly, which Hurley suggests as the only pre-requisite.

Where Hurley employs 160 pages to show programming techniques gently, Andrew Hewson takes his readers through his *Hints and Tips for the ZX-81* at a gallop in 75 pages. The book is based on one of the same title for the ZX-80 with the requisite amendments and, more important, deletions.

It is not designed for anyone who has yet to bang their heads for about 50 hours working-out Basic programming techniques. Most of it consists of solutions to problems of which the beginner is not yet aware and explanation is kept to a minimum.

The general style is along the lines of 'So you ran into that problem, too—here is the solution which seems best to me at the moment. Oh, and by the way, here are two things to avoid because they can really tie you in knots'.

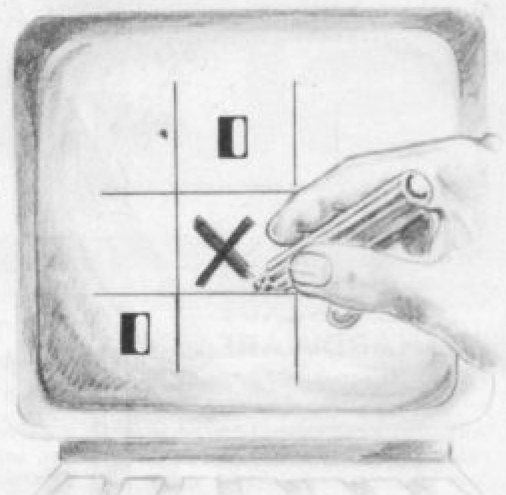
There are good, sound suggestions and techniques in the book but, in my opinion, it is designed for the committed and dedicated, although others could find it useful as a reference.

I liked particularily Hewson's warning about machine code programming—"Unfortunately writing lengthy programs in machine code is rather like solving *The Times* crossword. It is a pleasant intellectual challenge once you get the hang of it but until that time it can be a time-consuming and frustrating business. They are worth keeping in mind.

There is very little to say about Mark Harrison's *Byteing deeper into your ZX-81* beyond my opinion that it is one of of the best manuals on offer for the beginner. It assumes a small amount of general knowledge on the part of the reader but starts by describing what a computer is and leads through to the most advanced techniques of programming the ZX-81.

For anyone who has always avoided all things technical, *Peek, Poke, Byte and RAM* by Ian Stewart and Robin Jones would probably be a better book.

It makes no assumptions of knowledge and is well laid-out. The idiosyncratic asides along the lines of 'My cat did such and such' could be irritating to those who dislike that kind of thing.



Teaching Sinclair noughts and crosses

Philip Joy describes how to make the ZX-81 learn from its mistakes.

HOW THE end game of chess as played by a computer has little skill involved was explained last month. Most tend to advance their pawns as top priority, which is satisfactory if the other player lets you do it; mostly, though, he will have you in checkmate while you are messing about. Now I am going to tell you how a computer can be made to learn its mistakes and so build its skill factor.

The game in question is Noughts and Crosses, which you may say, is a simple game. In fact it is, but if you have ever played a computer version of the game, it tends to be very easy to beat. That is because it is not a game of chance but simply of using the correct moves at the proper time, a game of total skill not counting the chance about where the opponent is going. It is that fact which can lead to a computer learning its mistakes, hence finding all the correct moves and hence having a perfect skill rating.

To make the computer learn its mistakes requires very little work. In simple terms, the computer, if it goes first, can go in one of nine squares to start, one of seven squares on the second move, and so on.

To see which square it should choose, we must look how a human player would make his move. One thing he would do is to look at the computer's move; that is the single most vital point affecting the square where you go. When we had seen what the computer had done, he would use his judgment to decide from past experience the best square. The word past is vital, because it is no use knowing what square the opponent has chosen if you do not know the correct response.

Therefore for each move the computer would have a list of moves for each move the player made. They can be produced at random at the start of the game. If a game is lost, the computer's last move is thrown out and a new move put in its place which has not been tried previously. If all the moves have been tried at that point, the move prior to that is altered. In that way the more games played the computer will show more skill, until it should be unbeatable.

This type of game can be put on any microcomputer with about 16K of memory; you might like to try it using your ZX-81. If you do, I would be interested to see it and I could include part of it in one of these pages.

Next month I hope to produce a listing of a game called *Nim*, an old game about piles of matches. Two players take it in turn to take some matches from one pile at a time. There could be nine piles, for example, with say six in each, or any other combination. There are usually restrictions on the number of matches a player can take, say one to three per move.

The game can be put on your 16K ZX-81 with no difficulty. In the meantime, you could try to produce such a game which you could compare to the one I have written.

Your ZX-81 is perfect for producing such mind puzzles as anagrams and missing number sums.

I hope you can send any mind games I have mentioned so I can include them. I would also like to see any games you have played against the ZX-81 chess programs, whether against yourself or computers.

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